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SWS15100 AND SWS16100
SWEPT WAVELENGTH SYSTEMS

User's Manual

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JDS Uniphase

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For WINDOWS
Version: See User's Manual/CD ROM Label

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Terms

Acronyms

AC	Alternating current
ANSI	American National Standards Institute
APC	Angled polished connector, angled physical contact
ASCII	American National Standard for Communication Information Interchange
BW	Bandwidth
CD-ROM	Compact disk - read-only memory
CM	Control module
CW	Center wavelength
DBSSM	Dual band selector switch module
DC	Direct current
DIP	Dual inline package
DLL	Dynamic link library
DM	Detector module
DMA	Direct memory access
DUT	Device under test
DWDM	Dense wavelength division multiplexer
ECP	Extended capability port (parallel/printer)
EEPROM	Electrically erasable programmable read-only memory
EIA	Electrical Industries Association
EPP	Enhanced parallel port
ESD	Electrostatic sensitive device
FBG	Fiber Bragg grating
FWHM	Full width at half maximum
GHz	Gigahertz
GPIB	General purpose interface bus
GUI	Graphical user interface
IEEE	Institute of Electronic and Electrical Engineers
IL	Insertion loss
I/O	Input/output
ITU	International Telecommunications Union
LED	Light emitting diode

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MAV	Message available bit
MB	Megabyte
MDI	Multiple document interface
NIST	National Institute of Standards and Technology
nm	Nanometer
OWB	Optical Work Bench
PC	Polished connector, physical contact
PDL	Polarization dependent loss
pm	Picometer
PM	Polarization-maintaining
PMD	Polarization mode dispersion
PPI	Parallel port interface
RAM	Random access memory
RMA	Return material authorization
SCPI	Standard Commands for Programmable Instruments
SOM	Source Optics Module
SPP	Standard Parallel Port
SWS	Swept Wavelength System
TPS	Transmitter polarization state
UCA	Universal connector adapter
VB	Visual Basic
WDM	Wavelength division multiplexer

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Definitions

Analysis tab page	Where the user selects what type of analysis results are to be shown, and for which channels.
Bandwidth	The spectral width of a signal or filter. The bandwidth is defined as the width (in wavelength) of the peak of a beam measured at a specified threshold. The threshold is a power level below the maximum for a beam with a maximum peak or a power level below the average baseline, if the peak is a minimum.
Center wavelength	The interpolated wavelength marking the center of the peak measured at any threshold.
Channel	In SWS documents, channels refer to physical detectors. The upper detector on each detector module is an odd-numbered channel, while the lower detector is an even-numbered channel. In communications, the word “channel” is more specific to ITU channels, which are defined wavelength regions. Refer to ITU channels in full as “ITU channels” to avoid confusing the two.
Chart area	Where the data plots, Chart Resize button, and chart zooming control buttons are located.
Common area	The bottom left corner of the Main window where Channel Selection, Start and Stop Acquisition, and Reference buttons are located.
Configuration area	Contains the common area, status area, and tab pages.
Crosstalk	A value of Crosstalk describes the levels of the signal attributed to leakage of optical power into undesired wavelength ranges and compared to the performance of a DUT within its working region. Custom or ITU, adjacent and non-adjacent channels with their passbands, as well as discrete wavelengths (frequencies) can be used to specify those undesired wavelength ranges.
Dark voltage	The signal level obtained when blocking all light to the detector.
Flatness	The flatness of the device is a measure of the slope of a straight line that is a best linear fit to the top of the trace in a given channel. Flatness is calculated by finding the difference in power between the two points where the line crosses the band edges. The user defines whether to use passband, bandwidth, or some other numerical range.
Isolation	Defined for a Channel A with respect to a second (physically isolated) Channel B. It is the insertion loss of Channel A at the nearest guard band of Channel B.
Marker	A crosshair that moves along the channel data up and down in wavelength.
Marker tab page	The tab page where the user selects which markers are to be shown.
Minimum peak	The absolute minimum found in the insertion loss trace over the whole wavelength range.
Mueller matrix	The special matrix used to compute PDL.
Pan	Moves the image so that the last clicked position is brought to the

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	center of the plot. Subsequent pans use the same translation.
Passband	The operational region of a filter in spectral space. It is sometimes defined as the 6-dB bandwidth of a filter.
Process and Display Options tab page	The tab page where the user selects the type of trace to be displayed and the type of smoothing and averaging to be applied.
Reference marker	A special marker from which the coordinates of other markers, in wavelength and power, are measured.
Reference tab page	Where the user selects what reference is to be taken (dark voltage, zero loss, or both) and whether prompts are required after each channel.
Window resize buttons	If a window can be resized, there are three buttons. The left button is the Minimize button to minimize the window as an icon, the middle button is the Restore or Maximize button to toggle between the custom-sized window and the screen-size window, and the right one is the Close button to close or quit the current configuration window. If the window cannot be resized, only the Close button is available.
Window title area	Contains the name of the saved configuration window. The default is SWSConfiguration00n, where n = 0 to 255.
Zero loss	A reference measurement made with a fiber, against which relative power measurements are made.
Zoom in	Expands an image by reducing the X and Y scales. The center of the image is unaffected.
Zoom out	Reduces an image by increasing the X and Y scales, leaving the center of the image in the same position.

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Safety Information, Instructions, and Symbols

Safety Information

Classification

The equipment consists of an exposed metal chassis that is connected directly to earth via a power cord and, therefore, is classified as a Class 1 instrument. Class 1 refers to equipment relying on ground protection as a means of shock protection.

The following symbol is used to indicate a protective conductor terminal.

Disconnecting from Line Power

Some of the circuits are powered whenever the units are connected to the AC power source (line power). To ensure that a unit is not connected to the line power, disconnect the power cord from either the power inlet on the unit's rear panel or from the AC line-power source (receptacle). The power cord must always be accessible from one of these points. If a unit is installed in a cabinet, the operator must be able to disconnect the unit from the line power by the system's line-power switch.

Line Power Requirements

The equipment can operate from any single-phase AC power source that supplies between 100 and 240 V at a frequency range of 50 to 60 Hz. The typical maximum power consumption is 1500 W.

Fuse Type

The fuse type for the receiver is T2A/250 V. The fuse type for the source optics module is T1A/250 V. The fuse type for the tunable laser source is T4AL/250 V.

Laser Specifications

Laser specifications are outlined in Table 1.

Table 1: Laser Specifications

Parameter	Specification
Wavelength	1520 to 1570 nm (SWS15101 laser source, C-band) 1540 to 1630 nm (SWS16101 laser source, L-band) 1310 nm (source optics module)
Class	I
Output power	6 dBm or 4 mW (SWS15101), 3 dBm or 2 mW (SWS16101), and -3 dBm or 0.5 mW (SWS15102 or SWS16102)

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Under the laser classification of the US Food and Drug Administration (FDA) Center for Devices and Radiological Health (CDRH), the lasers contained in the system are Class I lasers.

Class I lasers are safe under reasonably foreseeable conditions of operation. There can be more powerful lasers inside the unit, but no harmful radiation can escape the enclosure.

Safety Instructions

The following safety instructions must be observed whenever the unit is operated, serviced, or repaired. Failure to comply with any of these instructions or with any precaution or warning contained in the user's manual is in direct violation of the standards of design, manufacture, and intended use of the unit. JDS Uniphase assumes no liability for the customer's failure to comply with any of these safety requirements.

Before Initializing and Operating the Equipment

☑ Inspect the equipment for any signs of damage, and read the user's manual thoroughly.

☑ Install the equipment as specified in the **Getting Started** section.

☑ Ensure that the equipment and any devices or cords connected to it are properly grounded.

Operating the Unit

Warning

To avoid the risk of injury or death, always observe the following precautions before initializing the equipment:

- Never look into the end of an optical cable connected to an optical output device that is operating. Laser radiation is invisible and direct exposure can severely injure the human eye. For more information, see the user's manual of the laser source in use.
- If using a voltage-reducing autotransformer to power the system, ensure that the common terminal connects to the earthed pole of the power source.
- Connect the power cord only to a power outlet equipped with a protective earth contact. Never connect to an extension cord that is not equipped with this feature.
- Turning off the power switch does not always block the externally supplied power to the connector at the output of the unit.
- To prevent potential fire or shock hazard, do not expose the unit to any source of excessive moisture.
- Do not use the unit outdoors.

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	• Do not operate the unit when its covers or panels have been removed. • Do not interrupt the protective earth grounding. Any such action can lead to a potential shock hazard that can result in serious personal injury. • Do not operate the unit if an interruption to the protective grounding is suspected. In this case, ensure that the unit remains inoperative. • Use only the type of fuse specified by the manufacturer as appropriate for this unit. Do not use repaired fuses, and avoid any situations that can short-circuit the fuse. • Use only the type of power cord supplied with the unit. • Repairs are to be carried out only by a qualified JDS Uniphase professional. • Disconnect the power cord from the unit before adding or removing any components to or from the installed system. • Operating the unit in the presence of flammable gases or fumes is extremely hazardous. • Do not perform any operating or maintenance procedure that is not described in the user's manual. • Some of the unit's capacitors can be charged even when the unit is not connected to the power source.

Safety Symbols

The following symbols and messages can be marked on each unit (Table 2). Observe all safety instructions that are associated with a symbol.

Table 2: Safety Symbols

Symbol	Description
	Laser safety. See the user's manual for instructions on handling and operating the unit safely.
	See the user's manual for instructions on handling and operating the unit safely.
	Electrostatic discharge (ESD). See the user's manual for instructions on handling and operating the unit safely.
	Frame or chassis terminal for electrical grounding within the unit.

(table continued)

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Symbol	Description
	Protective conductor terminal for electrical grounding to the earth.
WARNING	**The procedure can result in serious injury or loss of life if not carried out in proper compliance with all safety instructions. Ensure that all conditions necessary for safe handling and operation are met before proceeding.**
CAUTION	The procedure can result in serious damage to or destruction of the unit if not carried out in compliance with all instructions for proper use. Ensure that all conditions necessary for safe handling and operation are met before proceeding.

Compliance

CE Compliance

The unit has been designed and tested to comply with directive 73/23/EEC and its subsequent amendments by the European Community (EC or CE). The directive relates to electrical equipment designed for use within certain voltage limits. It ensures that electrical equipment is constructed with good engineering practice in safety matters.

The unit has been designed and tested to comply with directive 89/336/EEC and its subsequent amendments. The directive relates to electromagnetic compatibility. It demands that electromagnetic disturbance does not exceed a prescribed level; that the equipment be immune to a prescribed level of ambient level of interference; that the equipment be protected against electrostatic discharges; and that the equipment be immune to all electrical shock wave disturbances. As of 1997, measures have been added to test for fire hazard, electric shock hazard, and also external exposure to other forms of energy.

The requirements specified by directive 89/336/EEC are as follows. CE compliance requires that the manufacturer or its authorized representative established within the Community affix the EC conformity mark to the apparatus or else to the packaging, instructions for use, or guarantee certificate. The EC conformity mark shall consist of the letters CE as specified and the figures of the year in which the mark was affixed. This mark should, where appropriate, be accompanied by the distinctive letters used by the notified body issuing the EC type-examination certificate. Where the apparatus is the subject of other Directives providing for the EC conformity mark, the affixing of the EC mark shall also indicate conformity with the relevant requirements of those other Directives.

FDA-CDRH Compliance

Under the US FDA CDRH, the unit complies with the Code of Federal Regulations (CFR), Title 21, Subchapter J, which pertains to laser safety and labeling. See http://www.fda.gov/cdrh/radhlth/cfr/21cfr1000-1050.pdf for more information.

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General Information and Specifications

General Information

This user's manual for the Swept Wavelength System (SWS) contains complete operating instructions for using the SWS15100 and SWS16100 systems. For information on using the tunable laser source as a stand-alone unit, see the *SWS15101 and SWS16101 Tunable Laser Source User's Manual* (document SD000319). For information on the polarization controller, see the *SWS15104 Four-State Polarization Controller User's Manual* (document SD000327).

Wavelength division multiplexing (WDM), and especially dense WDM (DWDM), has become a key solution to the ever-increasing demand for network capacity and flexibility. Network device characteristics vary with wavelength; therefore, WDM systems are forcing the wavelength characterization of all components used in the system. Accurate characterization of the wavelength-dependence of a device previously required many time-consuming measurements. For example, in the past, characterization of a device over a range of 30 nm, with 0.1 nm resolution, required 300 measurements and took three or four hours to complete.

The Swept Wavelength System determines wavelength characteristics of devices used in optical networks. The SWS tests passive optical components for performance. The SWS can be used to test devices under operating conditions to maximize the efficiency of components. The system is available in two versions that have similar hardware components, cabling requirements, and operating procedures, but differ in the following specifications:

- Model SWS15100—C-band, 1520 to 1570 nm, completes a 50-nm scan with 0.003 nm resolution in six seconds, plus one and a half seconds per channel, using the parallel port interface
- Model SWS16100—L-band, 1540 to 1630 nm, completes a 90-nm scan with 0.003 nm resolution in eight seconds, plus three seconds per channel, using the parallel port interface

Devices that can be characterized by the SWS include:

- Attenuators
- Bandpass filters
- Broadband couplers and splitters
- DWDM demultiplexers
- Fiber Bragg gratings
- Isolators
- Switches
- Interleavers

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An important advantage of the SWS is that, when testing optical components with multiple outputs, such as DWDMs, all outputs can be tested simultaneously. As the number of outputs increases, the reduction in the total test time becomes more significant. The output parameters for which the SWS can be used to test are:

- Bandwidth
- Center wavelength
- Insertion loss (IL)
- Polarization dependent loss (PDL), using an optional controller
- Crosstalk
- Flatness
- Isolation

Bandwidth, center wavelength, IL, and PDL can be measured directly with the SWS software. Crosstalk, flatness, and isolation are obtained by subsequent data analysis. In addition, the user can select standard ITU channels, or define frequency bands, within which the SWS software computes relevant parameters, including center wavelength, passband, bandwidth, crosstalk, and flatness. In PDL mode, the SWS software also computes the average, minimum, and maximum insertion losses (over all polarizations), and polarization dependent loss, any two of which can be selected and plotted at one time.

The standard SWS, shown in Figure 1 with the optional polarization controller and a device under test (DUT), has six main components:

- Transmitter, which includes the source optics module and the tunable laser source
- Transmitter cabinet
- Receiver, with one control module and one or more detector modules
- Data acquisition board or parallel port interface
- Software
- User-supplied computer

Figure 1: Swept Wavelength System with Polarization Controller and Device Under Test

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Transmitter and Cabinet

The transmitter consists of a tunable laser source and a source optics module (SOM).

The tunable laser source provides the measurement signal for the DUT. It is continuously tunable, with no mode hops. Its default operational mode is continuously tuning 1520 to 1570 nm at 20 nm/s for the C-band version and 1541 to 1630 nm at 20 nm/s for the L-band version. Although operating instructions are contained in this manual for using the tunable laser source within the SWS, see the *SWS15101 and SWS16101 Tunable Laser Source User's Manual* (document SD000319) for more information.

The source optics module provides real-time measurement of the wavelength of the signal, filters the signal to improve its signal-to-noise ratio, and controls the tunable laser operation. The standard SWS package includes a single output on the front of the unit. Two or four output options are also available. The source optics module comes with standard FC/PC universal connectors.

The source optics module and the tunable laser source can be installed in the supplied transmitter cabinet. The cabinet is a standard half rack wide and three units high, in accordance with Standard EIA-310-D.

Receiver

The receiver measures the power throughput from the DUT and uses a proprietary protocol to communicate with the computer. The standard SWS package includes one receiver chassis, but more can be added to increase the number of channels and, therefore, the number of devices that can be tested.

The receiver chassis communicates with the user-supplied computer through the parallel port. A data acquisition board, available as an option, can replace the parallel interface. The board can be used to speed up data acquisition on systems with a large number of detector modules.

The chassis usually houses two types of modules: a control module and a detector module. The control module is a hardware controller for the receiver chassis. It synchronizes the transmitter and the receiver. It decodes the wavelength data sent by the transmitter and combines them with the power data read from the detector module(s). The detector module is a dual power detector; each detector module records power for two channels. The outputs from the DUT are connected to the detector module(s).

The chassis also houses the optional dual band selector switch module (DBSSM), if two transmitters are used for transmission of signals to the control module. The DBSSM can be switched to either input to obtain a wider wavelength span than is normally available using one transmitter.

Up to eight detector modules can be installed in each receiver chassis, with each detector module containing two detectors. Up to eight chassis can be used for each receiver station; therefore, up to 128 channels at a time can be measured for each receiver station. The SWS can also be expanded to four receiver stations for each transmitter.

A compact two-channel receiver is available, as an option, for users who do not need the expansion and multichannel capabilities of the standard receiver, but instead require a compact

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unit. This version of the receiver uses the parallel port interface for communication with the computer.

The system has a distributed architecture; that is, a transmitter with a single tunable laser source can be connected to multiple independent receivers, saving considerable test instrumentation costs. Optical fiber is used to connect each receiver station to the transmitter.

Data Acquisition Board

The optional data acquisition board is a parallel interface through which the computer communicates with, and controls, the receiver. It is installed in a user-supplied computer.

Software

The software performs several functions, including controlling the testing process, retrieving data, analyzing and summarizing data, plotting results, and storing raw data or processed results.

It displays measurement results versus wavelength or frequency. A zoom feature provides the capability to expand the display in both wavelength and amplitude. Retrieval of a plot for superimposition on an existing plot is possible. The software has a graphical user interface (GUI) that enables the selection of various data processing options, analysis functions, and display and storage options.

User-Supplied Computer

A computer is used to run the software, control the testing process, and use and store the results.

Key Features

- Ability to test simultaneously multiple outputs from a device
- Reduction in total test time as the number of outputs increases
- Distributed architecture—the laser source can be connected to multiple independent receivers
- Reduction in test instrumentation costs
- Absolute wavelength accuracy (±0.003 nm)
- Fast measurement (six seconds plus one and one half seconds for each channel for C-band or eight seconds plus three seconds for each channel for L-band, with the parallel port interface)
- Ability to expand wavelength range by combining outputs from two transmitters
- User-friendly software

Applications

- Characterization of high density demultiplexers
- Spectral response measurement of optical network components
- Research and development
- Manufacturing

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Standard Accessories

Standard components and accessories are listed in Table 3.

Table 3: SWS15100 System

Part Number	Description
SWS15100+C*n*	Standard C-band SWS system with n outputs: • Tunable laser (SWS15101) • Source optics module (SWS15102 and C1, C2, or C4) • Receiver chassis with one control module and one detector module (SWS15110) • Transmitter cabinet (OWB10001) • SWS CD-ROM • Accessories
A0105335	Cable for parallel port interface
ED003854-A-00	Ribbon cable daisy chain
ED003855-A-00	Termination cable
ED006406-F-00	Software distribution kit
J-FAFP-B-001-J1	FC/APC-FC/PC jumper (1 m, from receiver control module to DUT)
J-FAFP-B-010-J1	FC/APC-FC/PC jumper (10 m, from receiver to source optics module)
J-FPFP-B-0.3-J1	FC/PC jumper (0.3 m, from source optics module Signal Cond. In port to Signal Cond. Out port)
N/A	FC/APC-FC/PC jumper (1 m, polarization-maintaining fiber, from tunable laser source to source optics module; supplied with tunable laser source)
A0104218	RS232 cable
	All AC power cords
SD000317	*SWS15100 and SWS16100 Swept Wavelength System User's Manual*
SD000319	*SWS15101 and SWS16101 Tunable Laser Source User's Manual*

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Optional Components and Accessories

Optional components and accessories are listed in Table 4.

Table 4: Optional Accessories

Part Number	Description
SWS15100+C2	Standard C-band SWS system, with two outputs
SWS15100+C4	Standard C-band SWS system, with four outputs
SWS16100+C1	Standard L-band SWS system, with one output
SWS16100+C2	Standard L-band SWS system, with two outputs
SWS16100+C4	Standard L-band SWS system, with four outputs
SWS15101	Tunable laser source for C-band SWS
SWS16101	Tunable laser source for L-band SWS
OWB10002	Chassis for the receiver (common to C- and L-band systems)
SWS15106	Receiver control module (for either C- or L-band operation)
SWS15103	Dual band selector switch module (C- to L-band switching)
SWS15107	Dual detector module, with two additional detector channels for receiver (for either C- or L-band system)
ED006412-A-00	One-output module for the source optics module
ED006412-A-01	Two-output module for the source optics module
ED006412-A-02	Four-output module for the source optics module
SWS15110	Receiver (two-channel receiver with software; used either for C- or L-band operation) includes: • Chassis (OWB10002) • Receiver control module (SWS15106) • Dual detector module (SWS15107) • Interconnection cable • Fiber jumper (J-FAFP-B-001-J1)
A0103979	Data acquisition board
SWS15115	Compact two-channel receiver
SWS15104	Four-state polarization controller (for either C- or L-band operation)
SWS15113	Calibration kit, includes an acetylene cell and an HA9 Series Extended Range Programmable Optical Attenuator
SWS16117	L-band calibration kit, includes a gas cell and an HA9 Series Extended Range Programmable Optical Attenuator
SWS15116	Parallel port converter

(table continued)

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Part Number	Description
SWS16118	L-band gas cell (for wavelength calibration)
OWB10001	Transmitter cabinet for the transmitter components
SD000327	*SWS15104 Four-State Polarization Controller User's Manual*
AC100	Detector cap
AC101	FC detector adapter
AC102	ST detector adapter
AC103	SC detector adapter
AC115	E2000 detector adapter
AC118	LC detector adapter
AC120	Magnetic detector adapter
AC121	Bare fiber holder; requires AC120
J-FAFP-B-001	FC/APC to FC/PC jumper cable (1 m)
J-FASP-B-001	FC/APC to ST/PC jumper cable (1 m)
J-FASC-B-001	FC/APC to SC/PC jumper cable (1 m)
J-FASU-B-001	FC/APC to SC/APC jumper cable (1 m)

Specifications

The optical specifications describe the warranted characteristics of a unit. Supplementary specifications describe the typical non-warranted performance of a unit.

SWS15100 System

Table 5 outlines the optical specifications for the SWS15100 system.

Table 5: SWS Optical Specifications

Parameter	Specification
Fiber type	Siecor[1] SMF-28[2]
Connector type	Universal
Transmitter (SWS15102 source optics module) ferrule style	PC
Receiver (SW15110) ferrule style	APC

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(table continued)

Wavelength	
Wavelength range (C-band)	1520 to 1570 nm
Wavelength range (L-band)	1541 to 1630 nm
Wavelength resolution	0.003 nm
Absolute wavelength accuracy	±0.003 nm
Wavelength reproducibility	±0.001 nm (25 ±2 °C, <15 minutes)
Power	
Maximum recommended laser output power	3 dBm
Minimum power required by DUT in insertion loss mode	-15 dBm
Minimum power required by DUT in PDL mode	-20 dBm
Loss measurement accuracy in insertion loss mode, without four-state polarization controller (25 ±5 °C, >-15 dBm input to DUT)	±0.1 dB (0 to <20 dB) ±0.2 dB (20 to <40 dB) ±0.3 dB (40 to <50 dB)
Loss measurement accuracy in PDL mode, with four-state polarization controller (25 ±5 °C, >-20 dBm input to DUT)	±0.1 dB (0 to <10 dB) ±0.15 dB (10 to <20 dB) ±0.2 dB (20 to <30 dB) ±0.25 dB (30 to <45 dB)
Loss measurement resolution	0.01 dB
Loss measurement repeatability	±0.03 dB (>-15 dBm input to DUT)
Noise floor caused by source noise	>50 dB (>3 dBm laser input power to SWS15102 SOM)
Dynamic range of loss in insertion loss mode	>50 dB (>-15 dBm input to DUT)
Dynamic range of loss in PDL mode	>45 dB (>-20 dBm input to DUT)
Return loss at input of the CM	>50 dB
Maximum slope resolution	10 dB/pm (0 to 30 dB)
Measurement Time	
Measurement time for C-band	6 s + 1.5 s per channel (20 nm/s scan rate) using the parallel interface
Measurement time for L-band	8 s + 3 s per channel (20 nm/s scan rate)
Maximum number of outputs from DUT measured	128
Maximum number of receivers per transmitter unit	4

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(table continued)

PDL Measurements	
Accuracy (25 ±5 °C, >-20 dBm input to DUT)	±0.05 dB (0 to <10 dB) ±0.10 dB (10 to <20 dB) ±0.20 dB (20 to <30 dB) ±0.50 dB (30 to <45 dB)
Accuracy with 13 point smoothing and four averages (25 ±5 °C, >-20 dBm input to DUT)	±0.02 dB (0 to <10 dB) ±0.04 dB (10 to <20 dB) ±0.05 dB (20 to <30 dB) ±0.06 dB (30 to <45 dB)
PDL resolution	0.01 dB
PDL range	0 to 5 dB
User Interface	
Receiver control	Custom interface for Windows[3] 95 or Windows NT[4]
Receiver communication	Parallel port interface or Interface Card
Receiver data save	Tab delimited text file
Receiver data print	Windows 95/NT standard printer
Transmitter control	Front panel, GPIB, or RS232

[1] Siecor is a registered trademark of Siecor Brands, Inc.
[2] SMF-28 is a registered trademark of Corning Incorporated.
[3] Windows is a trademark of Microsoft Corporation.
[4] Windows NT is a trademark of Microsoft Corporation.

Transmitter

This section contains the specifications for the transmitter unit. The unit consists of the source optics module, the tunable laser source, and the cabinet.

Table 6 lists specifications for the source optics module.

Table 6: Source Optics Module Specifications

Electrical	
Input voltage	100 to 240 V AC, 50 to 60 Hz (autosensing)
Power consumption	100 VA maximum
Fuse type	T1A/250 V

(table continued)

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Physical	
Weight	7.7 kg
Dimensions (W x H x D)	48.3 x 13.3 x 37.5 cm (48.3 cm or 19 in subrack, 3 U high, in accordance with EIA-310-D; allow 10 cm front clearance and 8 cm rear clearance for cables)
Number of outputs	1, 2, or 4 (option is specified)
Environmental	
Operating temperature	10 to 40 °C
Storage temperature	-40 to 70 °C
Humidity	Maximum 80% RH at 40 °C (operating) Maximum 90% RH at 65 °C (non-operating)

Table 7 lists the optical specifications for the tunable laser source.

Table 7: Tunable Laser Source—Optical Specifications

Parameter	Specification
Mode hop-free range (P = 3 dBm) in C-band	1520 to 1570 nm
Mode hop-free range (P = 3 dBm) in L-band	1540 to1630 nm
Absolute wavelength accuracy	±0.2 nm
Tuning accuracy (on the mode hop-free range)	±0.02 nm
Tuning repeatability (on the mode hop-free range)	±0.005 nm
Wavelength setting resolution	0.001 nm
Optical frequency fine tuning range	±2 GHz
Power stability	±0.01 dB, peak-to-peak in 1 hour
Wavelength stability (at constant temperature)	0.001 nm
Typical linewidth (FWHM) (on the mode hop-free range)	100 kHz
Linewidth with coherence control	>100 MHz
Side frequency suppression ratio[1]	>35 dB
Optical connector	FC/APC
Remote control	RS232 and IEEE[2] 488.1

[1] Measured with a 100 MHz resolution Fabry-Perot interferometer.
[2] IEEE is a registered trademark of the Institute of Electrical and Electronics Engineers, Inc.

Table 8 outlines other specifications for the tunable laser source.

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Table 8: Tunable Laser Source—Other Specifications

Electrical	
Input voltage	100 to 240 V AC ±10%, 50 to 60 Hz
Fuse type	T4AL/250 V
Physical	
Weight	12.6 kg
Dimensions with front mounting handles (W x H x D)	48.3 x 13.3 x 43.2 cm 48.3 cm or 19 in subrack (in accordance with EIA-310-D; clearance of 7.5 cm rear and 1 cm bottom required)
Environmental	
Operating temperature	15 to 30 °C

Table 9 outlines the specifications of the transmitter cabinet.

Table 9: Transmitter Cabinet Specifications

Electrical	
Maximum power bar input voltage	100 to 240 V AC, 50 to 60 Hz
Number of receptacles	4
Breaker threshold	15 amp
Physical	
Weight	31.0 kg
Dimensions (W x H x D)	55 x 68 x 60 cm (cabinet for 48.3 cm or 19 in wide equipment, 12 U high, in accordance with EIA-310-D)

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Receiver

Table 10 outlines other specifications for the receiver unit.

Table 10: Receiver—Other Specifications

Electrical	
Input voltage	100 to 240 V AC, 50 to 60 Hz
Power consumption	170 VA maximum (per chassis)
Fuse type	T2A/250 V
Physical	
Weight	15.1 kg, with control module and eight detector modules
Dimensions (W x H x D) with front mounting handles	48.3 x 13.3 x 46 cm 48.3 cm or 19 in subrack, 3 U high (in accordance with EIA-310-D; allow 10 cm front clearance and 8 cm rear clearance)
Control and detector module dimensions (W x H x D)	4.0 x 10.7 x 35.5 cm
Maximum number of modules per chassis	1 control module 8 detector modules
Maximum number of chassis per receiver	8
Environmental	
Operating temperature	10 to 40 °C
Storage temperature	-40 to 70 °C
Humidity	Maximum 80% RH at 40 °C (operating) Maximum 90% RH at 65 °C (non-operating)

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Getting Started

The Swept Wavelength System consists of six main components:

- Transmitter, consisting of a source optics module and a tunable laser source
- Transmitter cabinet
- Receiver, with a control module and detector modules
- Parallel port interface or data acquisition board
- Software
- User-supplied computer

Before Initializing and Operating the Equipment

☑ Inspect the units for any signs of damage.

☑ Read the user's manual thoroughly, and become familiar with all safety symbols and instructions to ensure that the units are operated and maintained safely.

Initial Inspection

Warning

To avoid electrical shock, do not initialize or operate any unit if it bears any sign of damage to any portion of its exterior surface, such as the outer cover or panels.

Caution

- Acclimatize the tunable laser source for one to two hours after removing it from the shipping carton. Allow an additional hour of warm-up after the unit has been cycled and left on.
- Always use the key to power down the laser. Wait for the laser to park before switching the power off on the back panel.
- After turning off the tunable laser source, wait at least 30 seconds before powering it on again.

Check that the units and contents are complete:

1. Wear an anti-static wrist strap and work in an electrostatic discharge (ESD) controlled area.
2. Inspect the shipping containers for any indication of excessive shock to the contents, and inspect the contents to ensure that the shipment is complete.
3. Inspect the units for structural damage that can have occurred during shipping.
4. Ensure that the power switch is set to **O** (off).
5. Connect each unit to a power source, using the AC power cord provided.

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6. Set the power switch to **I** (on).

7. Keep the packaging.

Immediately inform JDS Uniphase and, if necessary, the carrier if the contents of the shipment are incomplete, if the equipment or any of its components are damaged or defective, or if any unit does not pass the initial inspection.

Operating Environment

In order for the units to meet the warranted specifications, the operating environment must meet the following conditions for temperature, humidity, and ventilation.

Temperature

The source optics module can be operated in the temperature range of 10 to 40 °C. The tunable laser source can be operated in the temperature range of 15 to 30 °C. The receiver can be operated in the temperature range of 10 to 40 °C.

Humidity

The equipment can be operated in environments with up to 80% humidity (10 to 40 °C). Do not expose it to any environmental conditions or changes to environmental conditions that can cause condensation to form inside the unit.

Ventilation

Do not install the equipment in any location where the ventilation is blocked. For optimum performance of the fan, the source optics module, transmitter cabinet, and receiver chassis require 10 cm (4 in) front clearance and 8 cm (3 in) rear clearance. The tunable laser source and receiver chassis contain built-in cooling fans. When installed in the transmitter cabinet, the ventilation requirements for the tunable laser source are met. Blocking the air circulation around the instruments can cause the instruments to overheat, compromising their reliability.

Warning

- Do not use the units outdoors.
- To prevent potential fire or shock hazard, do not expose the units to any source of excessive moisture.

Storing and Shipping

To maintain optimum operating reliability, do not store the units in locations where the temperature falls below -40 °C or rises above 70 °C. Avoid any environmental condition that can result in internal condensation. Ensure that these temperature and humidity requirements can also be met whenever the unit is shipped.

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Claims and Repackaging

Immediately inform JDS Uniphase and, if necessary, the carrier, if

- The contents of the shipment are incomplete
- The unit or any of its components are damaged or defective
- The unit does not pass the initial inspection

In the event of carrier responsibility, JDS Uniphase allows for the repair or replacement of the unit while a claim against the carrier is being processed.

Returning Shipments to JDS Uniphase

JDS Uniphase only accepts returns for which an approved Return Material Authorization (RMA) has been issued by JDS Uniphase sales personnel. This number must be obtained prior to shipping any material to JDS Uniphase. The owner's name and address, the model number and full serial number of the unit, the RMA number, and an itemized statement of claimed defects must be included with the return material.

Ship return material in the original shipping container and packing material. If these are not available, typical packaging guidelines are as follows:

1. Wear an anti-static wrist strap and work in an ESD controlled area.

2. Wrap the unit in anti-static packaging. Use anti-static connector covers, as applicable.

3. Pack the unit in a reliable shipping container.

4. Use enough shock-absorbing material (10 to 15 cm or 4 to 6 in on all sides) to cushion the unit and prevent it from moving inside the container. Pink poly anti-static foam is the best material.

5. Seal the shipping container securely.

6. Clearly mark FRAGILE on its surface.

7. Always provide the model and serial number of the unit and, if necessary, the RMA number on any accompanying documentation.

8. Ship the unit only to the address given at the beginning of this document.

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Cleaning Connectors

	Caution • Connecting damaged or dirty fibers to the unit can damage the connectors on the unit. • Never force an optical connector. Some connectors have a ceramic ferrule that can easily be broken.

Optical cable ends need to be cleaned before using them with the unit.

The following items are required for cleaning:

- Filtered compressed air or dusting gas (for example, Tech Spray Envi-Ro-Tech Duster 1671 gas, available from http://www.techspray.com/1671.htm)
- Lint-free pipe cleaners (for example, from 3M[1]) or lint-free swab
- Lint-free towels (for example, 10 x10 cm or 4 x 4 in HydroSorb III wipers, available from http://www.focenter.com/acctech/hydrosobr_wipers.htm)
- Optical grade isopropyl alcohol or optical grade 200° ethanol (do not use rubbing alcohol, which contains 30% water)

To clean the connectors:

1. Blow the sleeve with filtered compressed air (Figure 2).

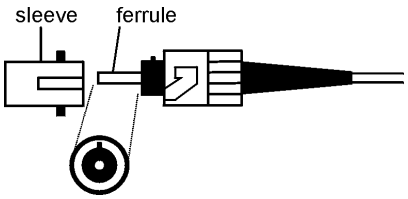

Figure 2: Connector Cleaning (connector type can vary)

2. Apply optical grade isopropyl alcohol or optical grade ethanol (do not use rubbing alcohol) to a small area of a lint-free towel and rub the end of the ferrule over the wet area.

3. Wipe the ferrule on a dry area of the lint-free towel.

4. Using the dusting gas or compressed air, blow the end of the ferrule.

5. Apply the alcohol or ethanol to a lint-free pipe cleaner or swab and wipe off the remaining parts of the connector.

6. With the other end of the pipe cleaner or swab, dry the areas cleaned.

7. Using the dusting gas or compressed air, blow the areas cleaned.

[1] 3M is a trademark of 3M.

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Installation

The Swept Wavelength System consists of six main components: a transmitter, a transmitter cabinet, receiver, application software, and a user-supplied computer with parallel port interface or data acquisition board. The data acquisition board is an optional component. The tunable laser source and the source optics module are the two components of the transmitter. This section outlines instructions for setting up, powering, and testing the system.

Installing the Transmitter

The transmitter, packed in three boxes, consists of:

- Source optics module
- Tunable laser source
- Transmitter cabinet

As outlined below, install the source optics module and tunable laser source in the transmitter cabinet, which comes fully assembled.

Source Optics Module

The source optics module box contains the following items:

- SWS15102 or SWS16102 source optics module
- 9-pin RS232 D-sub cable
- FC/PC 0.3 m jumper
- AC power cord
- Certificates of calibration and test reports
- Packing slip

Tunable Laser Source

The tunable laser source box contains the following items:

- SWS15101 or SWS16101 tunable laser source
- FC/APC-FC/PC 2 m polarization-maintaining fiber jumper
- Mounting hardware
- Power enable key
- AC power cord
- *SWS15101 and SWS16101 Tunable Laser Source User's Manual* (document SD000319)

Transmitter Cabinet

The transmitter cabinet box contains the following item:

- OWB10001 transmitter cabinet

The transmitter cabinet is completely assembled.

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Installing the Source Optics Module and Tunable Laser Source

Figure 3 and Figure 4 show the transmitter unit setup from the front and back. The polarization controller, shown on the top shelf, is optional.

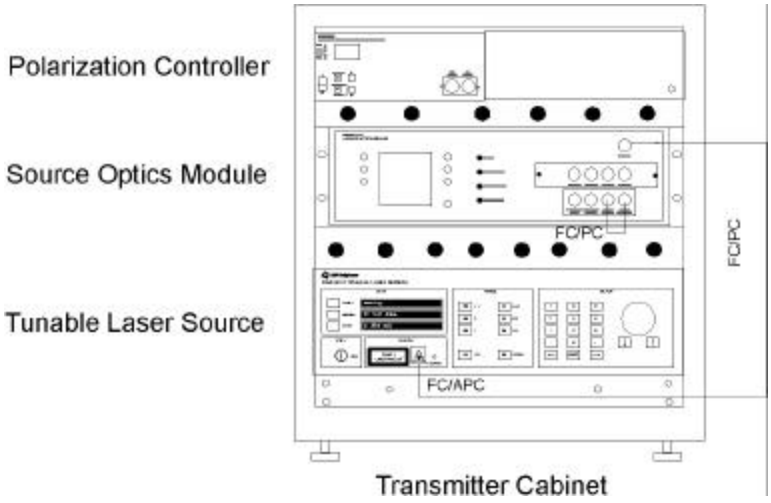

Figure 3: Transmitter Unit Front Setup

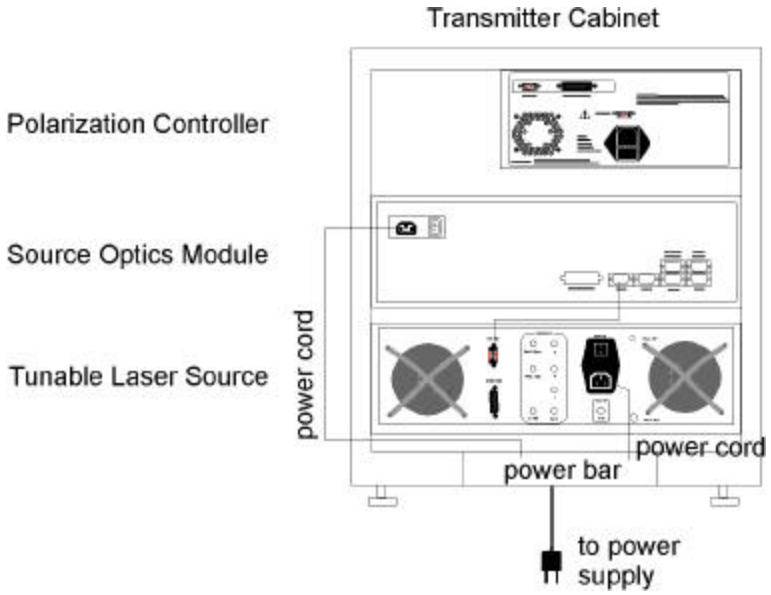

Figure 4: Transmitter Unit Rear Setup

The source optics module comes with standard FC/PC universal connectors. Do not interchange them with the FC/APC universal connectors on the receiver control module. See the **Attaching Universal Connector Adapters** section for more information on UCAs.

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To install the source optics module and the tunable laser source in the transmitter cabinet:

1. Using the hardware provided, install the tunable laser source in the lower opening in the transmitter cabinet, as shown in Figure 3.

2. Lift the connector cover on the laser source. The cover is marked by the laser warning sign and shields the output port. Connect the FC/APC end of the 2 m FC/PC-FC/APC PM fiber to the Optical Output port on the laser. The green sheath on the end of the fiber signifies an FC/APC connector. This green connector goes into the laser input.

3. Route the PM fiber through the left-most grommet in the lower fiber-routing panel. Push the fiber through the rightmost grommet and out to the front of the panel.

4. Using the hardware provided, install the SOM above this panel.

5. Connect the PC end of the 2 m FC/PC-FC/APC PM fiber to the Laser In port on the front of the SOM.

6. Using the 0.5 m FC/PC jumper, connect one end to the Signal Cond. In port and the other end into the Signal Cond. Out port, both of which are at the front of the SOM. The space above the laser source, behind the fiber-routing panel, can be used to stow the jumper.

7. Using the 9-pin RS232 serial cable, connect one end to the RS232 input at the back of the laser source. Connect the other end to the Aux. 1 port at the back of the SOM.

8. Connect one of the supplied universal power cords to the back of the SOM and plug the other end into the universal power bar in the transmitter cabinet.

9. Connect a universal power cord to the back of the laser source and plug the other end into the power bar.

10. Plug the power cord, supplied with the system, into the power bar in the transmitter cabinet and the other end into an AC power source.

11. Clean and connect the FC/PC connector on the 10 m FC/PC-FC/APC jumper to one of the output ports on the SOM.

12. Route this fiber to the outside through either fiber-routing panel to the back of the transmitter cabinet. The fiber can be taken out of the cabinet either through the grommet holes at the top or the opening at the bottom.

13. Repeat the previous step for all required outputs.

14. Turn on the power bar. Reset the breaker on the power bar.

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Caution

The Relay port on the rear panel of the source optics module enables remote control of the relay drivers. Although the connector is a 9-pin RS232-type connector, it is not an RS232 port. Do not connect a standard RS232 cable to this port.

The laser source and SOM can be installed in other 48.26 cm (19 in) racks or cabinets. If installed in other racks, provide additional support rails to hold the equipment in the rack.

Setting and Verifying Default Source Optics Module Values

The system, as supplied, is set with the correct default values. To check or change values, the default values are:

- **Start wavelength**—wavelength at which laser scanning of the DUT begins for a C-band transmitter (1519.5 nm) or for an L-band transmitter (1540.8 nm). Do not change this value.
- **Stop wavelength**—wavelength at which laser scanning of the DUT ends in a C-band system (1575 nm) or in an L-band transmitter (1635 nm)
- **Delay**—1 s is the time delay between sweeps
- **Polarizer**—mode 0
- **Power**— 3 dBm is the output power from the laser
- **Sweep rate**—20 nm/s is the rate of wavelength change (laser scanning)

The default values are set at the factory and are based on the model of the SOM. To verify or modify defaults, see the **Setting Source Optics Module Parameters** section.

Powering Up the Source Optics Module and Tunable Laser Source

Caution

- Acclimatize the tunable laser source for one to two hours after removing it from the shipping carton. Allow an additional hour of warm-up after the unit has been cycled and left on.
- Always use the key to power down the laser. Wait for the laser to park before switching the power off on the back panel.
- After turning off the tunable laser source, wait at least 30 seconds before powering it on again.

To start the source optics module and the tunable laser source:

1. Ensure that the tunable laser source has been acclimatized outside the shipping carton for one to two hours.

2. Turn the switch at the rear of the tunable laser source laser to **I** (on).

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3. Turn on the key on the front of the tunable laser source. The unit beeps and the front panel lights up.

4. Cycle the power on the tunable laser source: turn off the unit using its key, wait at least 30 seconds after the power is off, and turn the unit on again using the key.

5. Turn the power switch at the back of the source optics module to **I** (on). The front panel lights up, the version number of the firmware is displayed, and the main menu is displayed on the front panel.

6. A warm-up time of two hours is required before the system is ready for measurements. It is recommended that the system be left on at all times.

For information on using the tunable laser source, see the *SWS15101 and SWS16101 Tunable Laser Source User's Manual* (document SD000319).

Replacing Output Ports on the Source Optics Module

The SWS is shipped with the specified number of output ports installed. The number of receivers connected to a transmitter can be increased to increase the number of measurement stations. This modification requires changing the output ports on the front of the source optics module, to a maximum of four outputs.

The standard SWS package includes one output port on the source optics module; the two or four output port option can be specified at the time of ordering. The ports are labeled Output 1, Output 2, Output 3, and Output 4 on the front of the source optics module. To reconfigure the system, the output modules can be changed. Order option ED006412-A-00 for one output, option ED006412-A-01 for two outputs, or ED006412-A-02 for four outputs.

To replace an output module:

1. Unscrew and gently remove the output port cassette from the front of the source optics module (Figure 5).

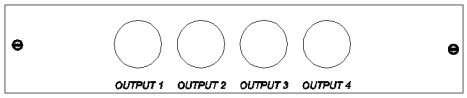

Figure 5: Four Output Ports on Source Optics Module

2. Disconnect the FC/PC connector attached to the back of the module. Ensure that no stress is applied to the jumper while disconnecting or connecting the output module.

3. Clean and connect the FC/PC connector to the new module being inserted.

4. Insert the output cassette by feeding the fiber back into the source optics module and pushing the cassette back horizontally into its slot. Screw the plate to the front of the source optics module.

Installing the Standard Receiver Chassis

The receiver chassis houses three elements:

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- Control module
- Detector module
- Dual Band Selector Switch Module (optional)

The control module and detector module are wrapped in anti-static packaging in the receiver box, which contains the receiver, cabling, and software:

- OWB10002 chassis
- Control module
- Detector module(s)
- SWS software on CD-ROM
- *SWS15100 and SWS16100 Swept Wavelength System User's Manual* (document SD000317)
- Parallel port interface cable
- 50-pin ribbon termination cable
- 50-pin ribbon cable
- Two FC detector adapters per detector module
- Two FC/PC-FC/APC hybrid jumpers (1 m and 10 m)
- Power cord

To install the SWS software using the CD-ROM, see the **Installing the Software** section.

Assembling the Receiver

The standard SWS system includes one control module and one detector module. More detector modules are included if more than one is specified when ordering. The control module and detector modules are installed in the receiver chassis. The first receiver chassis in a series contains the control module; additional chassis in the series do not require additional control modules.

Figure 6 and Figure 7 show the receiver setup from the front and back. This configuration shows three detector modules.

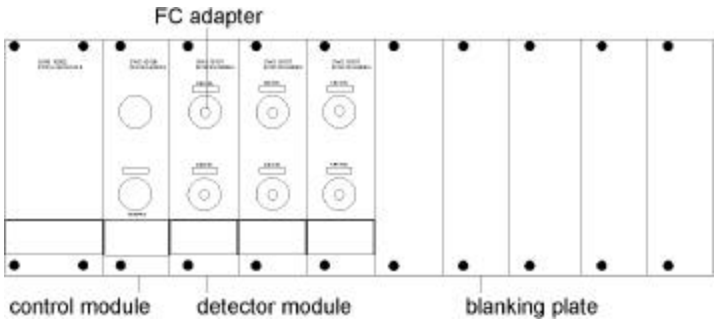

Figure 6: Receiver Front Setup

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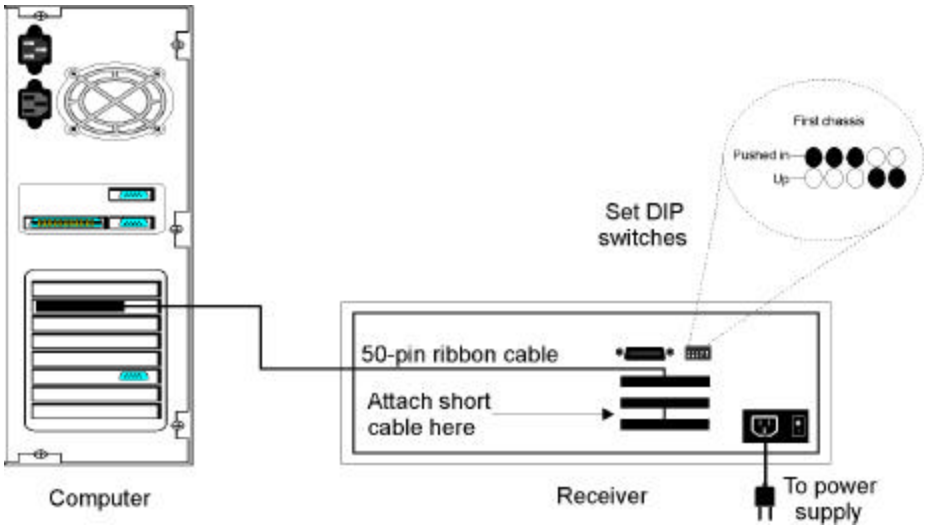

Figure 7: Receiver Rear Setup

If there is more than one receiver chassis, use the following instructions to install the first chassis. To add additional chassis, see the **Installing Additional Receiver Chassis** section.

	Caution The detector modules are not hot swappable. Turn the power off before installing or removing a detector module.

To assemble the receiver:

1. Place the chassis on a solid surface near the user-supplied computer. The unit is also rack-mountable (48.26 cm or 19 in wide rack). If rack mounting the chassis, use angle brackets (user-supplied) on the bottom of the unit, in addition to the front screws. Ensure there is sufficient clearance (10 cm front, 8 cm rear) for air intake and exhaust.

2. Insert the control module into the first slot, on the front left side of the chassis, and fasten it using the screw fasteners.

3. Insert the detector module into the next slot and fasten it tightly using the screw fasteners to ensure proper grounding of the detector module. If there are more detector modules, wait before installing them; see the **Installing Additional Detector Modules** section for detailed instruction.

At the back of the chassis, attach one end of the short 50-pin termination cable into the Termination connector (bottom port) and the other end into the Additional Chassis connector (middle port), also at the back of the chassis.

Using the Dual Band Selector Switch Module (DBSSM) with the SWS

The Dual Band Switch Selector Module (DBSSM) is an add-on component to the Swept Wavelength System (SWS). It enables switching between two transmitters, so that data can be

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collected over a wider wavelength range. This section explains how to install the DBSSM in the SWS, and how to use the switch for dual transmitter operation.

Installing the Dual Band Selector Switch Module (DBSSM)

Figure 8 below shows the front panel of the DBSSM.

Figure 8. Front panel of the Dual Band Selector Switch Module (DBSSM)

The DBSSM has two input connectors marked “TX1” and “TX2”, and one output connector. All three are FC/APC connectors. The LED display at the top is used as an indicator, to indicate the switch number and the transmitter currently selected. An FC/APC-FC/APC connector is supplied with the DBSSM.

	Caution **The modules are not hot swappable. Turn off the power to the receiver chassis before installing or removing a module.**

The recommended location for the DBSSM is the last slot, that is to the right of the detector modules in the last chassis. Tighten the screws at the top and the bottom.

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After the module is physically in place, connect one transmitter, normally the C-band, to the port marked “TX1”. The connector must be FC/APC. Connect the other transmitter to the port marked “TX2” using the FC/APC end of the fiber from the second transmitter. Finally, use the supplied FC/APC-FC/APC jumper to connect the output of the DBSSM to the input to the Control Module.

Connecting the Parallel Port Interface

To connect the parallel port interface (PPI) to the receiver make sure that the computer you are about to use has its parallel port configured to SPP or bi-directional protocol. Please contact your system support specialist to verify the settings if needed.

1. Connect the supplied 25-pin cable to the printer port on the computer.
2. Connect the other end of the cable to the connector labeled Parallel Interface on the back of the receiver.
3. Press down the upper part of the right-most DIP switch, labeled Parallel Port Enable on the back of the receiver. Power up the OWB. The Parallel Interface LED should come on.

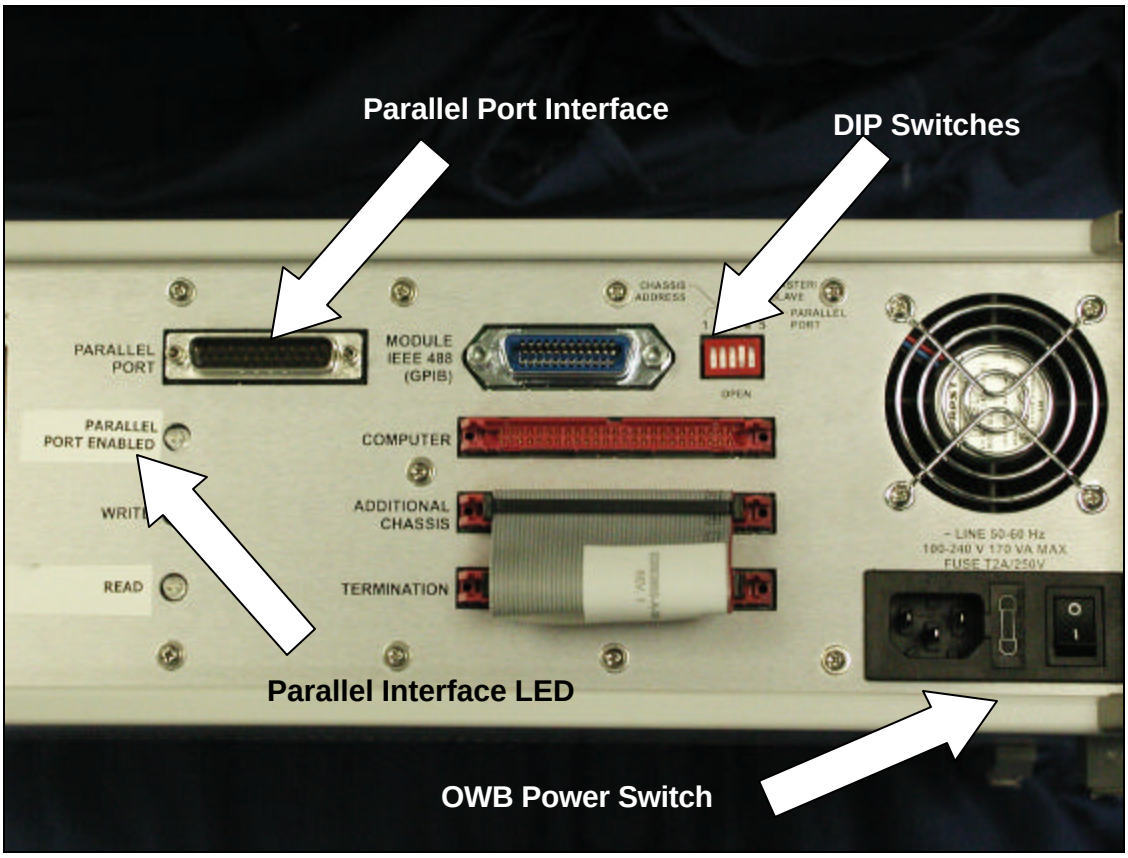

Figure 9. DIP switch settings.

4. If you already have SWS software installed on the computer, please start Configure SWS I/O Interface program. A shortcut is located under the Start button, in the Programs, SWS15100 section. Choose the parallel port interface option and also select the LPT port, to which you

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have the receiver connected. If you are not sure of the LPT position, Autodetect option can also be used. For more details, see the **Installing the Software** section.

5. From the same group of shortcuts (Start -> Programs -> SWS15100), launch SWS Setup Test Wizard. See the following image.

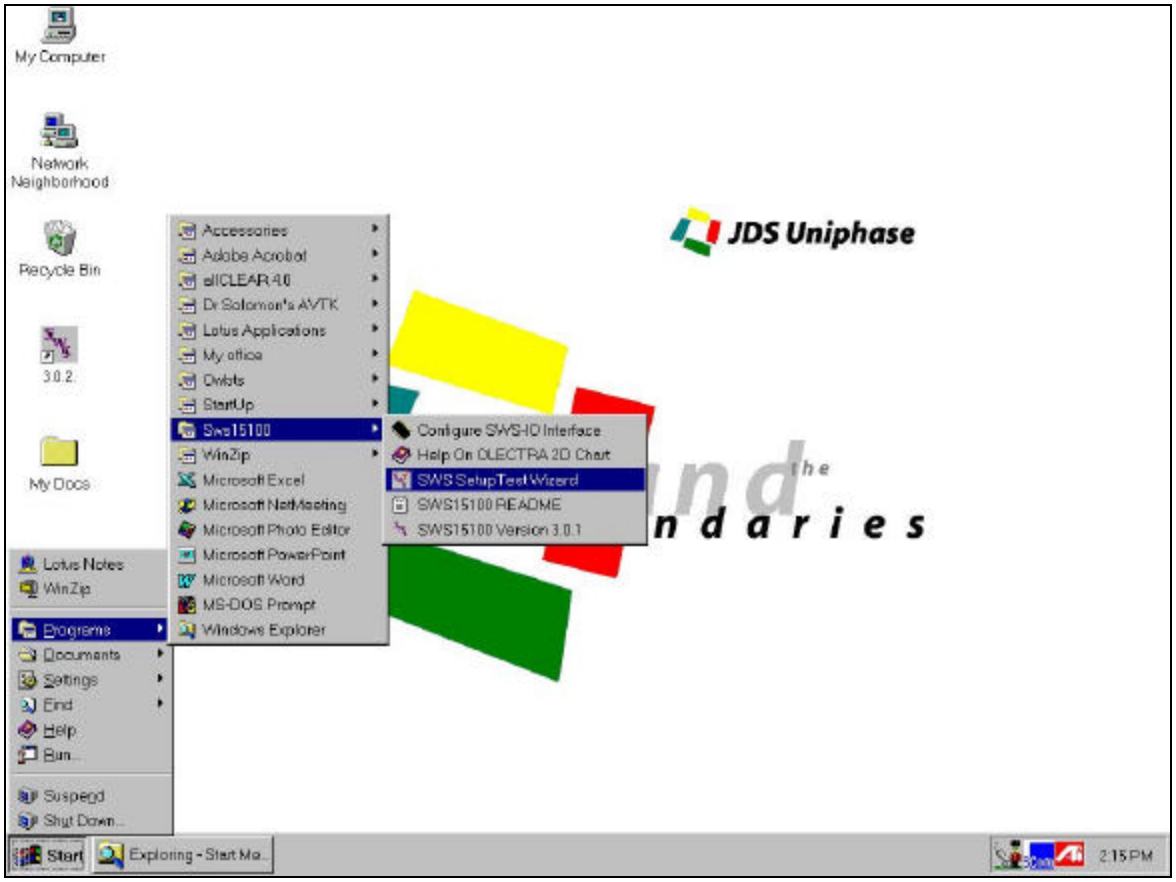

Figure 10. Starting the SWS Setup Test Wizard.

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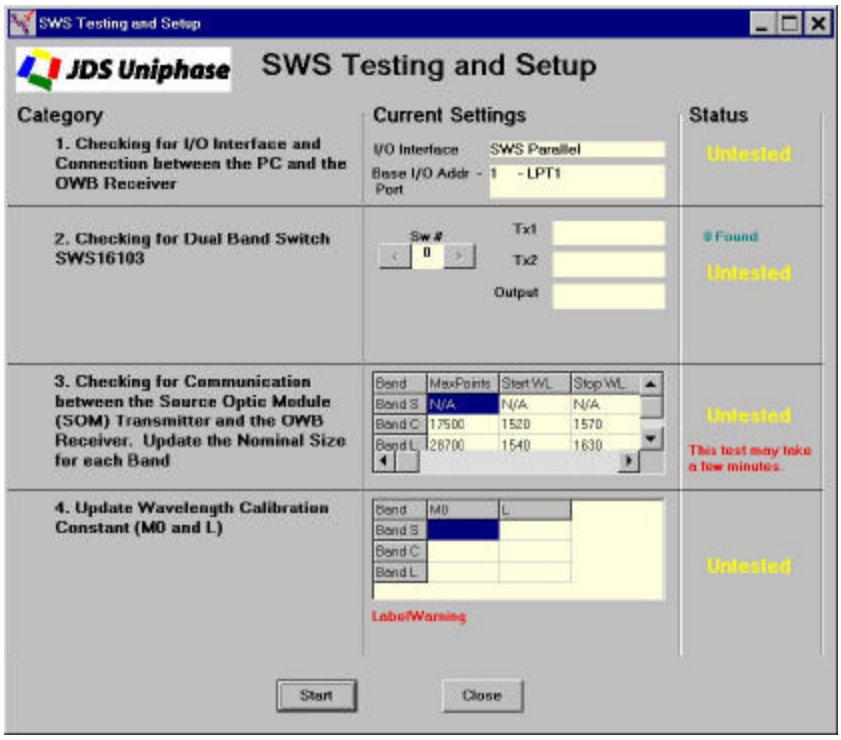

Figure 11. SWS Test and Setup Wizard.

6. Once you have the optical link established between the SOM and the Control Module of the receiver and the laser is scanning, run the Wizard by clicking on the Start button in the bottom of the form.
7. For a new system, all the configuration steps are included in the standard SWS setup package distributed on the CD-ROM.

When the steps above are completed including the SWS software installation, the PPI is ready to be used for collecting data from the receiver.

Should there be any difficulty installing, configuring or running the PPI, please refer to the troubleshooting guide on the **Parallel Port Interface Troubleshooting**.

If the data acquisition board is used instead of the PPI, see the **Installing the Data Acquisition Board** section for installation instructions.

Installing Additional Receiver Chassis

Up to eight chassis can be used for each receiver station. Each chassis holds eight detector modules; therefore, up to 128 channels can be measured at a time (or 126 if DBSSM installed). The units are connected in a daisy-chain configuration using the top two 50-pin connectors at the back of each chassis.

To add an additional receiver chassis and connect it to an existing chassis:

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1. Turn off the power at the back of all existing receiver chassis. The units do not need to be unplugged.
2. Find the DIP switch on the back of the chassis. It should look like one of the following

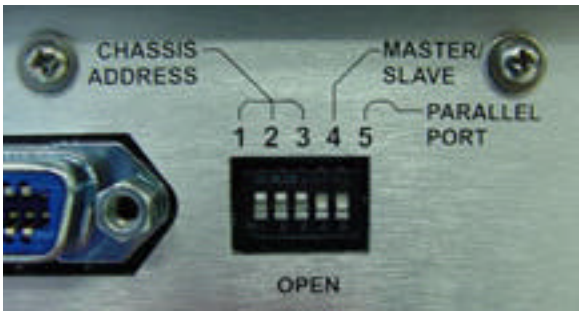

Figure 12. Black DIP switches on older versions of chassis

Figure 13. Red DIP switches on newer chassis.

3. Set the DIP switch at the back of the new chassis to the next available address (Figure 14).

Figure 14: Additional Chassis DIP Switch Setup

4. As shown in Figure 15, remove the short termination cable from the middle and bottom 50-pin connectors (Additional Chassis and Termination ports) at the back of the last chassis in the set. Connect the jumper to the same connectors on the new chassis. For example, take the jumper from the fourth chassis and connect it to the fifth chassis.

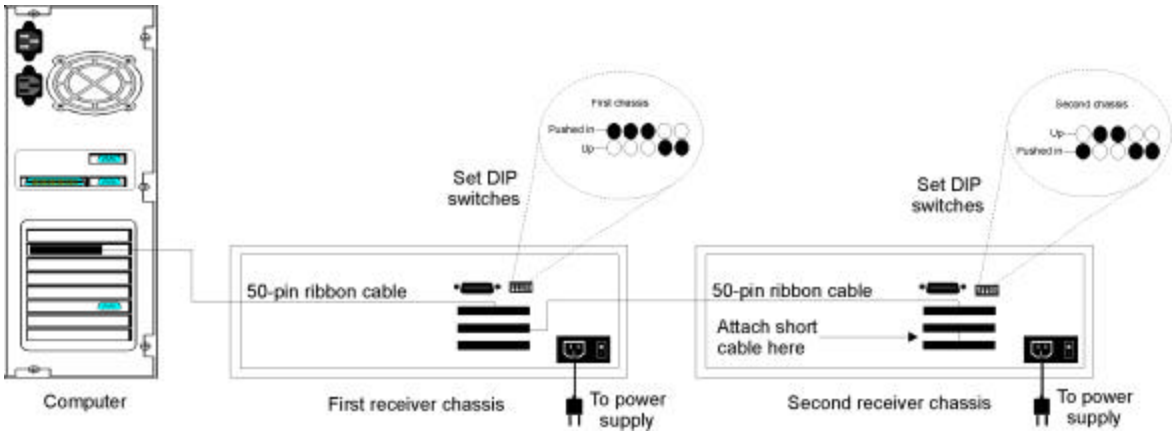

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Figure 15: Setup for Adding a Receiver

5. Using the 50-pin ribbon fiber cable provided with the new chassis, attach one end to the (middle) Additional Chassis connector of the last chassis in the set. Attach the other end to the (top) Computer connector of the new chassis.

6. Attach the AC power cord provided to the new receiver chassis and to the AC power source.

7. Turn the power on for each chassis.

Powering Up the Receiver

To start the receiver, turn the power switch at the back of the chassis to **I** (on). It is recommended that the receiver be left on at all times.

The LEDs on the Control Module and Detector Module do not light up when the receiver is powered on. The LEDs on the receiver will not activate until the software is initialized.

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Connecting the Transmitter

After the transmitter and receiver have been installed, the components must be connected to each other.

1. Set up the system as shown (Figure 16).

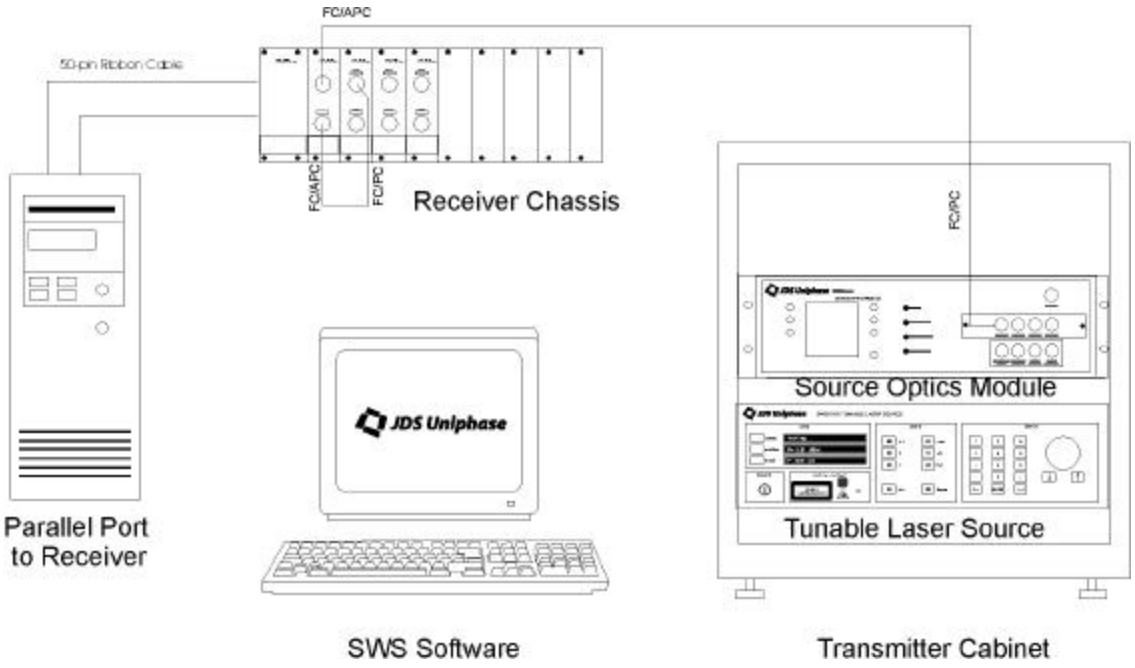

Figure 16: SWS Front Setup

2. A 10 m hybrid (FC/PC-FC/APC) jumper is supplied with the receiver; the FC/PC end has a black boot and the FC/APC end has a green boot. Attach the FC/APC end to the Tx In connector on the receiver's control module (top port). Connect the flat FC/PC end to any Output port on the front of the source optics module.

3. Using the 0.5 m hybrid jumper supplied with the receiver, attach the FC/APC end to the To Device connector on the receiver's control module (bottom port). Connect the flat FC/PC end to the first channel on the receiver's detector module.

Installing Additional Detector Modules

More detector modules can be added to the chassis to enable testing of several channels simultaneously. The standard SWS package includes a chassis that can hold eight detector modules and a single control module. When more than eight detector modules (16 channels) are required, the extra modules are installed in the system by adding another chassis. Order the required number of SWS15107 Dual Detector Modules. Each additional chassis (OWB10002 Chassis) includes the required 50-pin ribbon cable. Up to eight chassis can be daisy-chained together to form one receiver station.

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To add a detector module to an existing receiver chassis:

1. Turn off the power at the back of the receiver. The unit does not need to be unplugged.

	Caution The detector modules are not hot-swappable. Turn the power off before installing or removing a detector module.

2. Remove the individual blanking plate from the front of the chassis; the next available slot is recommended so that channel numbering is contiguous.

3. Slide in the new detector module into the slot. Ensure that the module locks into place.

4. Securely fasten the top and bottom screws to ensure proper grounding of the detector module.

5. Turn on the power.

6. Test the receiver after the software is installed.

Attaching Detector Adapters

The DUT or its jumper, or both, determine which adapter is used to connect the DUT to a detector module of the receiver chassis. The standard SWS system includes two FC detector adapters (AC101).

Each new detector module is supplied with two blank detector caps and the correct universal connector adapters. The blank detector caps are attached for shipping purposes and can also be used when making dark voltage measurements. Unscrew the detector caps and replace them with the appropriate adapter for the DUT and its jumper. Table 4 in the **Specifications** section lists the adapters that can be ordered from JDS Uniphase.

To attach a DUT to a detector module:

1. Unscrew and remove blank detector caps on the front of the detector module.

2. Select the appropriate adapters and attach them to the detector module.

3. Attach the DUT to the detector module.

Attaching Universal Connector Adapters

The source optics module is supplied with standard FC/PC universal connectors. The control module on the receiver is supplied with two FC/APC universal connectors. These are the only connectors that can be used on the source optics module and the control module and they are not interchangeable between the two. To install the connectors, follow the procedure outlined in the previous section. Figure 17 shows a UCA and a connector. The difference between the FC/PC and FC/APC universal connectors is shown in Figure 18.

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Figure 17: Adapter and Connector

In Figure 17, the top part is a connector insert (for example, FC or SC). The bottom part is a UCA.

Use care when removing and cleaning UCAs. There are two types of adapters, FC/PC and FC/APC (Figure 18). Do not interchange the two types. The UCAs on the source optics module are of the same type: FC/PC. The adapters on the receiver control module are both FC/APC. The two types can be distinguished by observing the alignment slot on the connector end. In FC/PC adapters, the slot points to the straight edge or side of the square. In FC/APC adapters, the slot points to a corner. If an FC/PC adapter is installed on the control module, the FC/APC ferrules do not mate properly, which leads to excessive losses.

Figure 18: Universal Connector Adapters

switch

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Installing the Compact Two-Channel Receiver

The compact two-channel receiver is an optional substitute for, or add-on to, the larger OWB10002 chassis-based receiver. The two-channel receiver can be installed only as the first receiver in a daisy-chained series of receiver chassis. To install the receiver:

1. Connect the supplied parallel port cable to the parallel port on the computer and to the parallel port connector on the two-channel receiver.

2. If the receiver is being daisy-chained, connect the 50-pin ribbon cable to the connector on the back panel of the two-channel receiver.

3. Connect the other end of the 50-pin ribbon cable to the uppermost 50-pin connector on the OWB10002 chassis.

4. Plug the unit into a power socket, ensuring that the ground for this receiver is the same ground as for the other receiver modules and the computer.

5. The optical connections to the two-channel receiver are on the front panel. Connect the output of the source optics module to the input of the receiver (left-most FC/APC connector).

6. The output of the control module is located beside the input of the receiver. Use the supplied FC/PC-FC/APC 1 m jumper to connect the output of the control module to Channel 1 or Channel 2.

7. Connect the other end of the FC/APC cable to the Control Module output.

8. The receiver cannot be tested at this point. Proceed with the rest of the installation, including installing the software, as explained in the following sections.

Installing the Data Acquisition Board

The computer system can use the optional data acquisition board instead of the parallel interface. To install the data acquisition board:

1. Configure the data acquisition board:

    a) Ensure the computer is powered down.
    b) Remove the data acquisition board from its ESD bag.
    c) Verify the settings of the DIP switches and jumpers on the board. Set the DIP switches settings as shown in Figure 19.

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Figure 19: Dip Switch Settings on the Data Acquisition Board

2. Verify that the DMA channel is selected properly. For this, place jumpers in the upper-right two rows and the lower-middle two rows.

3. Set the interrupt level by jumpers in Row 4 from the left and Row 3 from the left on W2.

4. Verify that STANDBY and BRDCLK-OSC are jumped together on W3. These settings are factory default settings. They need not be changed, unless some other board on the computer uses the same address on interrupt level. There is no need to install the driver and diagnostics software supplied with the data acquisition card.

5. Connect the data acquisition board's 50-pin ribbon cable, found at the back of the computer in a 50-pin slot, to the Computer connector at the back of the receiver chassis (top port).

6. At the back of the receiver chassis, arrange the DIP switches as shown in Figure 20. The first three DIP switches set the address for the receiver and chassis and the fourth DIP switch is always in the position shown. The fifth DIP switch is used to select either the parallel port interface or data acquisition board interface, whichever is installed in the computer.

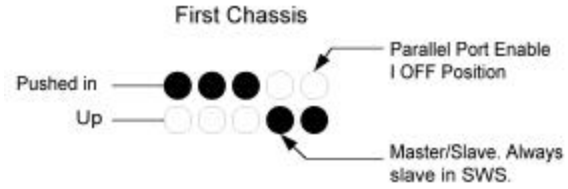

Figure 20: Receiver Address DIP Switch Setup

7. Attach the power cord to the back of the chassis and connect the other end to a power supply.

8. On the front of the unit, unscrew the detector caps on the detector module and attach the FC detector adapters. There are two adapters for each detector module.

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Installing the Software

The software performs several functions, including controlling the testing process, retrieving data, summarizing data, plotting results, and storing data.

The software displays measurement results versus wavelength. Markers can be programmed to show specific results, such as bandwidth. A zoom feature provides the capability to expand the display in both wavelength and amplitude. A plot can be superimposed on another plot.

Minimum Hardware Requirements

The standard interface used to acquire data from the receivers is the parallel port interface. As an option, the National Instruments[2] AT-DIO-32F data acquisition card can be used. When installing the SWS software, specify which interface is installed. If the AT-DIO-32F is installed, the user-supplied computer must have at least one available full-size ISA slot.

The minimum hardware requirements for the user-supplied personal computer are listed in Table 11.

[2] National Instruments is a trademark of National Instruments.

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Table 11: Minimum Hardware Requirements

Component	Description
Processor	200 MHz Pentium[1] microprocessor
Operating System	Microsoft Windows 95/98 or Windows NT
Memory	32 MB RAM
Storage	1 GB free hard disk space required, 2 GB recommended
Monitor	SVGA, 38 cm (15 in), 1024 x 768 resolution required
Drives	CD-ROM drive

[1] Pentium is a registered trademark of Intel Corporation.

To install the software:

1. Restart the computer.

2. Ensure that the transmitter and receiver are connected and powered-on as described earlier in the **Connecting the Transmitter** section.

3. Make sure the SOM is set to sweep in Polarization Mode 0 and press the Execute button on the source optics module to start the transmitter and enable the receiver to process the optical inputs to it.

4. Insert the SWS CD-ROM, which is packed in the receiver box, into the computer drive. From the Windows Start menu, choose the Run option. The Run window appears.

5. Type d:**setup** (if using drive d) and click the OK button. The SWS software is installed on the computer.

6. Follow the steps of the installation program until it brings you to the SWS Testing and Setup Wizard.

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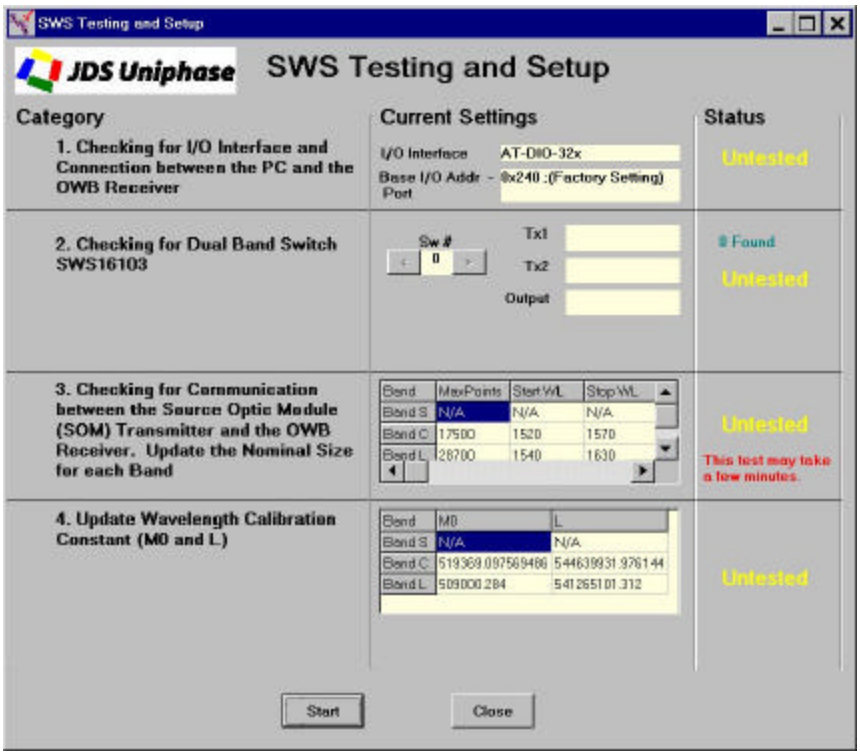

Figure 21. Starting SWS Testing and Setup Wizard.

7. It is going to test four sections of the setup: I/O Interface, a Dual Band Switch (if applicable), optical communication between the receiver and the SOM and initial wavelength calibration. Click Start button to run the Wizard.
8. Firstly, the Wizard allows the user to choose what kind of interface is to be used. The I/O Data Acquisition card is a default option. If it is the option you are currently using in your setup, the Wizard checks the communication between the computer and the receiver. If the I/O interface does not match the default option the user is prompted to reconfigure the interface.

9. When the program executes, a dialog box appears (Figure 22). The text boxes at the top show the default (or current, if changed) configuration.

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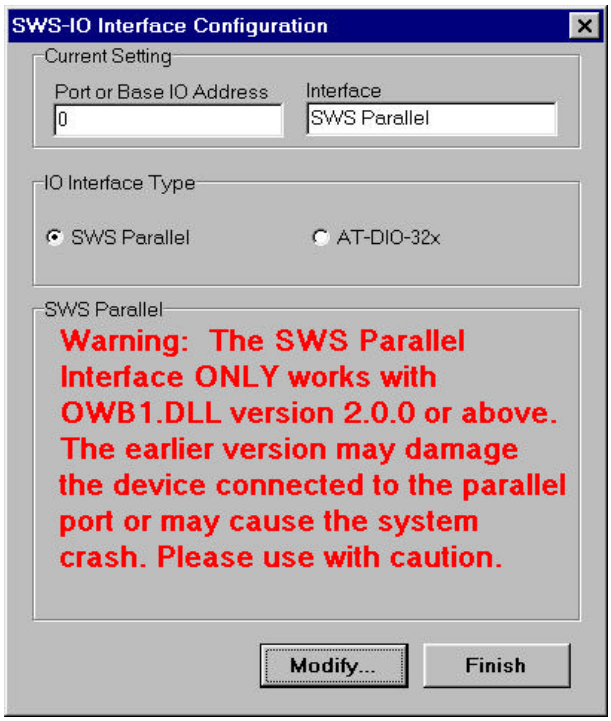
SWS-IO Interface Configuration
Current Setting
Port or Base IO Address
0
Interface
SWS Parallel
IO Interface Type
SWS Parallel
AT-DIO-32x
SWS Parallel
Warning: The SWS Parallel Interface ONLY works with OWB1.DLL version 2.0.0 or above. The earlier version may damage the device connected to the parallel port or may cause the system crash. Please use with caution.
Modify...
Finish

Figure 22: Interface Configuration

10. Click the SWS Parallel radio button to select the parallel interface or the AT-DIO-32x button if the data acquisition card is installed. The text boxes do not change when the radio button is pressed.

11. To effect the change, click the Modify button. A new dialog box appears (**Figure 23**). In this dialog box, the parallel port is selected. If the port number is unknown, there is only one port, or the first port is in use, select 0. If the port is LPT1 or LPT2, select it by clicking the arrow to highlight the selection. The selection appears in the text boxes at the top. Verify that the configuration is correct. Click the Finish button.

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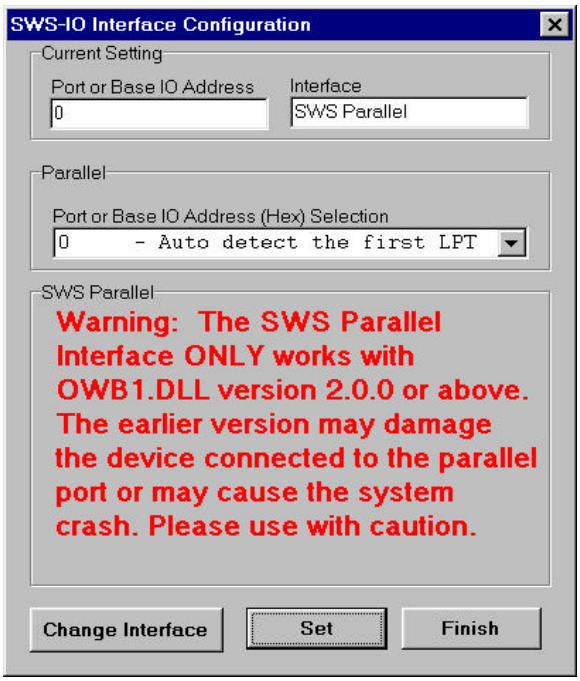
SWS-IO Interface Configuration
Current Setting
Port or Base IO Address
0
Interface
SWS Parallel
Parallel
Port or Base IO Address (Hex) Selection
0 - Auto detect the first LPT
SWS Parallel
Warning: The SWS Parallel Interface ONLY works with OWB1.DLL version 2.0.0 or above. The earlier version may damage the device connected to the parallel port or may cause the system crash. Please use with caution.
Change Interface
Set
Finish

Figure 23: Selecting the Parallel Port

The selected configuration is listed in the message box shown in Figure 24.

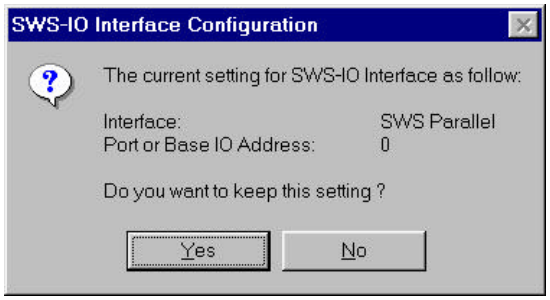
SWS-IO Interface Configuration
The current setting for SWS-IO Interface as follow:
Interface: SWS Parallel
Port or Base IO Address: 0
Do you want to keep this setting ?
Yes
No

Figure 24: Selecting the Interface Configuration

12. Click the Yes button to verify the selection.

13. As the next step the Wizard checks if a Dual Band Selector Switch (PN SWS16103) is present in the setup. If the switch is properly installed into the OWB chassis and fully operational the Wizard should indicate the results of the tests as shown on a figure below.

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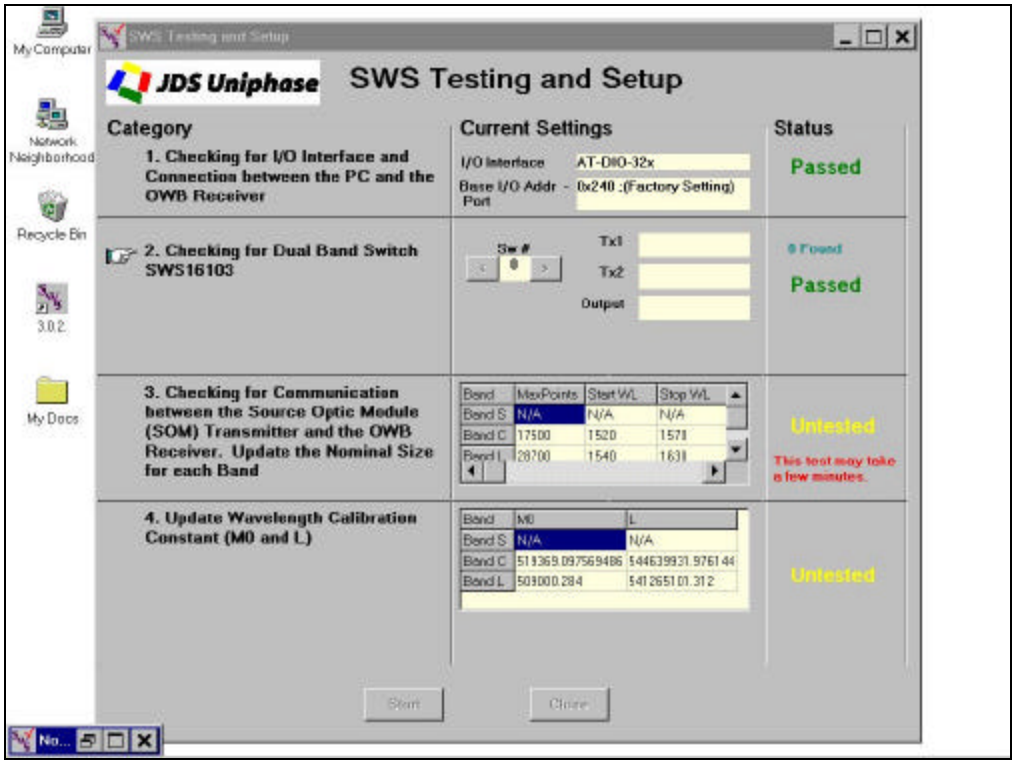

Figure 25. Testing I/O interface and a Dual Band Switch.

If a Dual Band Switch is present in the setup the Wizard prompts the user to specify the band information for every port of the switch, e.g. Tx1 is set to C-band and Tx2 is set to L-Band.

14. The third section of the Wizard tests the communication between the SOM and the receiver by counting the number of data points collected by the Control Module of the receiver while sweeping over any of the bands (C, L or both). Please choose a band in the drop down list of the dialog box.

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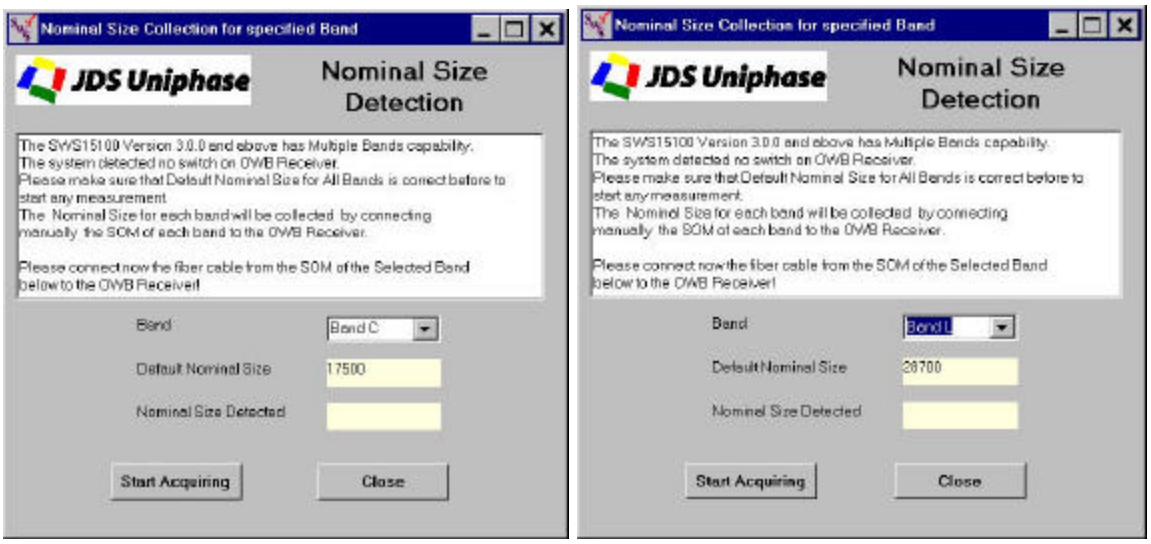
Nominal Size Collection for specified Band
JDS Uniphase
Nominal Size Detection
The SWS15100 Version 3.0.0 and above has Multiple Bands capability.
The system detected no switch on OWB Receiver.
Please make sure that Default Nominal Size for All Bands is correct before to start any measurement.
The Nominal Size for each band will be collected by connecting manually the SOM of each band to the OWB Receiver.
Please connect now the fiber cable from the SOM of the Selected Band below to the OWB Receiver!
Band
Band C
Default Nominal Size
17500
Nominal Size Detected
Start Acquiring
Close
Nominal Size Collection for specified Band
JDS Uniphase
Nominal Size Detection
The SWS15100 Version 3.0.0 and above has Multiple Bands capability.
The system detected no switch on OWB Receiver.
Please make sure that Default Nominal Size for All Bands is correct before to start any measurement.
The Nominal Size for each band will be collected by connecting manually the SOM of each band to the OWB Receiver.
Please connect now the fiber cable from the SOM of the Selected Band below to the OWB Receiver!
Band
Band L
Default Nominal Size
28700
Nominal Size Detected
Start Acquiring
Close

a) C-Band **b) L-Band**

Figure 26. Testing the data collection procedure in C (a) and L (b) bands.

Then click Start Acquiring button to launch the test. Once the Nominal Size Detected matches the Default Nominal Size, the test is successfully completed.

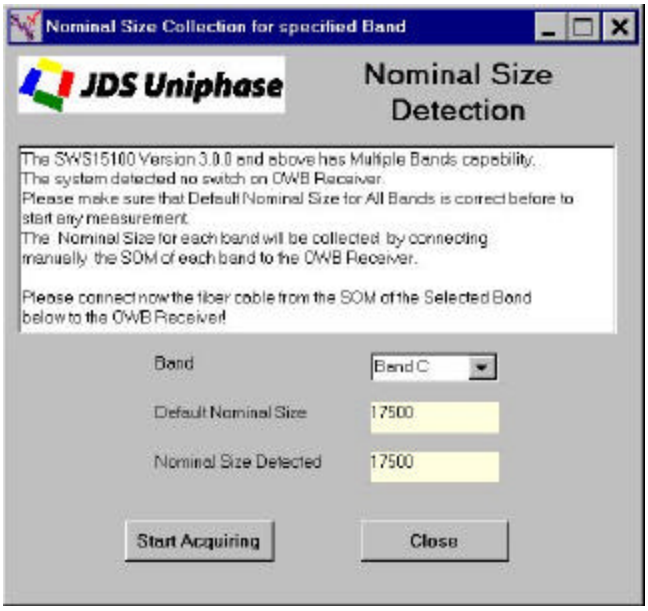
Nominal Size Collection for specified Band
JDS Uniphase
Nominal Size Detection
The SWS15100 Version 3.0.0 and above has Multiple Bands capability.
The system detected no switch on OWB Receiver.
Please make sure that Default Nominal Size for All Bands is correct before to start any measurement.
The Nominal Size for each band will be collected by connecting manually the SOM of each band to the OWB Receiver.
Please connect now the fiber cable from the SOM of the Selected Band below to the OWB Receiver!
Band
Band C
Default Nominal Size
17500
Nominal Size Detected
17500
Start Acquiring
Close

Figure 27. Nominal Size Detection.

Click the Close button to finish this section of the Wizard. If the test fails please check:

- If the SOM is sweeping in the EXECUTE mode;
- A cable connecting the SOM to the Control Module;
- If the right band is chosen.

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This test usually takes a few minutes due to the fact that the Nominal Size of the data array is tested over several scans to ensure the consistency of the system's operation.

15. In the last section, the Wizard analyses the contents of the EEPROM of the Control Module of the receiver, where the default values of the wavelength calibration are stored. The Wizard returns a "PASSED" status if the calibration parameters M0 and L are within range for the Bands tested. Subsequent calibration (see "**Calibrating the Equipment**") may be necessary to ensure the specified accuracy.

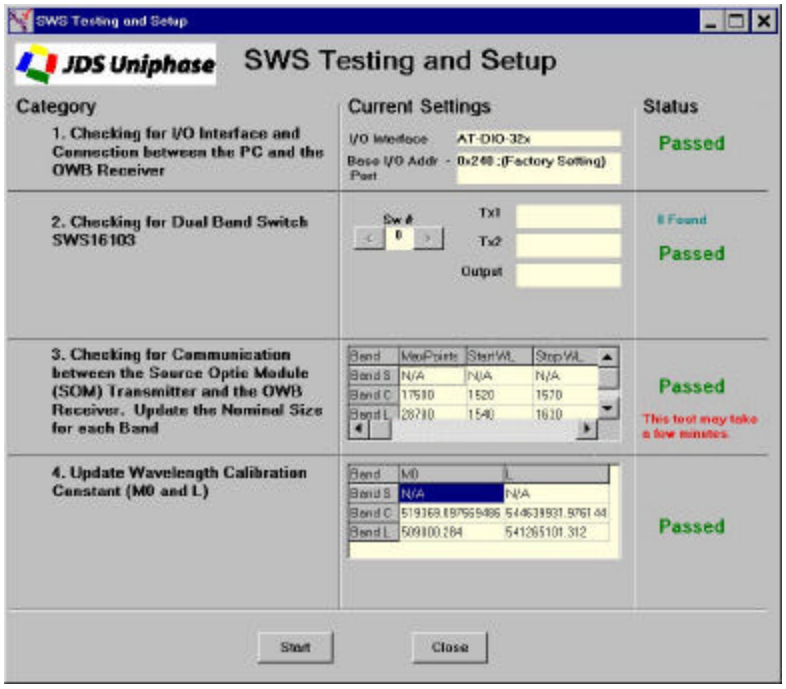

Figure 28. The SWS Testing and Setup Wizard. Test complete.

16. This section will fail if the M0 and L wavelength calibration values are missing or out of range. Once all the sections are successfully completed, click the Close button to return to the SWS Setup program.

17. Please also note that the SWS Testing and Setup Wizard can be run at any time when you make any changes in the SWS setup and you wish to test an overall system's performance. The Wizard can be launched using a shortcut located under the Start button.

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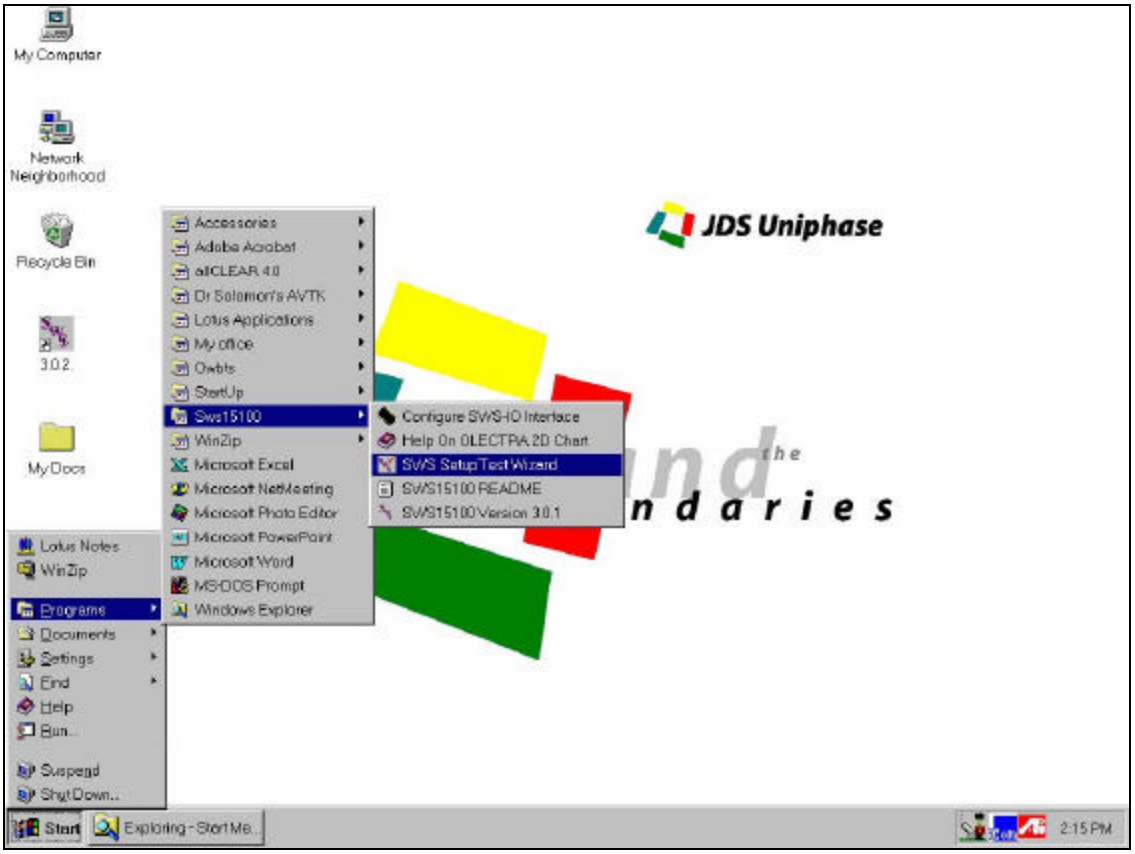

Figure 29. Starting the Wizard from the Start button.

Testing the SWS Components

Testing the Receiver

When the SWS software installation is complete, test the receiver:

1. Start the SWS software. When installed, the program can be run from the Start menu.

2. Verify that the LED on the Control Module displays “CM01”.

3. Verify that the LEDs on the Detector Modules display “C001”, “C002”, and so on. The channel number corresponds to the location of the detector module in the chassis. The detector modules nearest the CM are Channel 1 and Channel 2. The upper channel in each DM is the odd-numbered channel.

If preliminary tests fail, the computer is not communicating properly with the receiver. Test the parallel port of the computer by connecting the port to a printer or other parallel device, or test the data acquisition board, if that option is installed.

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Testing the Parallel Port Interface

If problems are encountered with the parallel port interface, it can be tested easily by unplugging the receiver and substituting a standard printer. Use an application program such as Notepad to print a small file. If the print procedure is successful, the parallel interface works. Verify that the parallel port installed in the computer is a standard DB25M port. The printer port must be in SPP mode to operate with the SWS.

Testing the Data Acquisition Board

Test the data acquisition board if the software does not produce the expected results. For example, if listing channels is not possible, test the data acquisition board. Prior to testing the data acquisition board, ensure that the 50-pin connector on the board is not damaged. Remove the 50-pin ribbon cable and inspect the pins on the connector. Verify that none are broken or bent. Reinsert the cable and try again. If the problem persists, test the data acquisition board.

Set the DIP switch or jumper settings for the board to the default values, which are listed in the board's user's manual. The default addresses need to be changed only when there is a conflict on the computer.

To test the data acquisition board, its software needs to be installed, following the instructions in the user manual for the board. The SWS software does not need to be installed to test the data acquisition board. Likewise, the data acquisition board software is not needed for the SWS to run.

To test the data acquisition board:

1. Follow the instructions provided in the data acquisition board manual, specifically the **Installation** and **Troubleshooting** sections.

Testing the Output Ports

To test that the output ports are functioning properly on the source optics module:

1. Ensure that the source optics module is not scanning. The Laser Sweeping light on the front of the unit is off when the unit is not scanning.

2. Put the tunable laser source into manual mode by ensuring that the Remote key on the front panel is not lit. The Remote key toggles on and off when it is pressed.

3. Set the power on the laser source to 3 dBm. Press the Enable key on the front panel. Verify that the output laser power is within 0.5 dB of the set value using a power meter.

4. Measure the IL through the SOM to the output ports using an external power meter hooked up to the Output 1, Output 2, Output 3, or Output 4 port on the front of the source optics module. The nominal IL value for one output is approximately 6 dB. There is a 3 dB increase in loss for the two-output module and a 6 dB increase in loss for the four-output module. The measured power specifications are:

   1-output cassette >-8 dBm

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2-output cassette	>-11.5 dBm
4-output cassette	>-15 dBm

5. Test the remaining output ports.

If the unit does not appear to be functioning properly:

1. Clean the connectors of the Output port on the front of the source optics module. Test the output ports again. If this fails, proceed to Step 2.

2. Remove the output port plate from the source optics module, disconnect the FC/PC connector from the back of the plate, and measure the power directly from this FC/PC connector cable. The power measured is ideally at >-8 dBm. If the power is correct, reinstall the output cassette and test the output ports again.

3. If the problem persists, call JDS Uniphase.

Testing the System

Prior to any functional testing of the SWS hardware, verify that the optical connections and components are correct. To verify connections:

1. Set the tunable laser source to manual mode, ensuring that the Remote key on the front panel is not lit. The Remote key toggles on and off when it is pressed. If the key does not toggle, press the Stop button on the source optics module, then the Execute button on the source optics module.

2. Set the tunable laser source to 3 dBm.

3. Connect a power meter to the To Device port on the front of the receiver by using a jumper.

4. Verify that the power reading on the power meter is >-15 dBm. If it is not, clean all fiber connections, ensure that all connectors are tight, and redo the test. If the condition persists, contact JDS Uniphase.

When component testing is complete, the assembled SWS can be tested to ensure that parameters (for example, IL, minimum and maximum power, bandwidth, or center wavelength) are measured correctly. Two simple tests that can be performed are:

- Referencing and verifying minimum noise
- Checking the wavelength accuracy of the SWS

Testing System Noise

To reference and verify minimum noise:

1. Select a channel and perform a zero-loss reference in the insertion loss mode.

2. Acquire a trace with the same jumper and channel that was referenced in step one. The scan will be automatically displayed on the chart area of the SWS software.

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3. The ideal trace displayed on the screen is a straight line at 0 dB insertion loss, with a noise level less than ±0.025 dB.

4. Repeat the procedure for each available channel.

If all traces acquired are within the ±0.025 dB noise specification, the detector modules are functioning properly. If any channel fails, remove the jumper, clean the ferrules, and redo both the reference and data acquisition. If the channels are still noisy, or if the insertion loss deviates by more than 0.05 dB from 0, call JDS Uniphase for service.

Acquire the dark voltage reference. To acquire dark voltage readings, follow the instructions in the **Using SWS Software** section.

If the data cannot be collected, or if the system issues a "System timed out" or "Communications" error message, there may be a problem with the computer interface to the receiver. Confirm that the data acquisition board or parallel port connector is properly configured and operational. See the **Testing the Data Acquisition Board** section.

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Source Optics Module Front Panel

Figure 30 shows the front of the model SWS15102 source optics module. Model SWS16102 is similar.

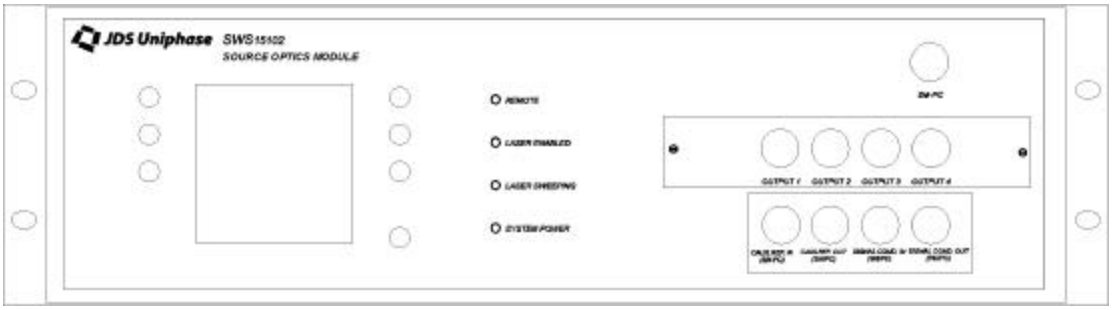

Figure 30: Source Optics Module Front Panel (Model SWS15102)

Source Optics Module Rear Panel

Figure 31 shows the back panel of the source optics module.

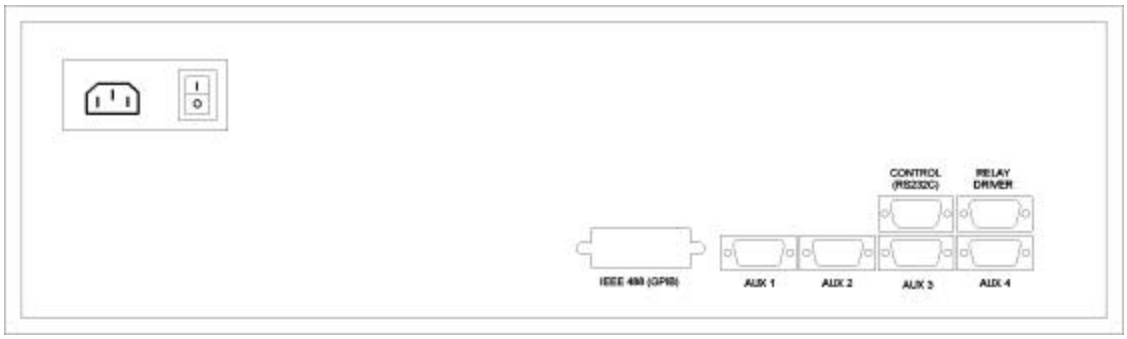

Figure 31: Source Optics Module Rear Panel

Tunable Laser Source Front Panel

Figure 32 shows the front of the tunable laser source.

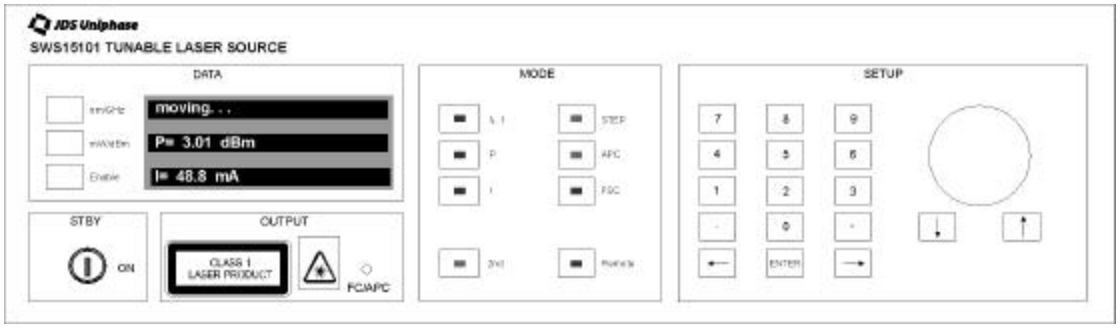

Figure 32: Tunable Laser Source Front Panel

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Tunable Laser Source Rear Panel

Figure 33 shows the rear panel of the tunable laser source.

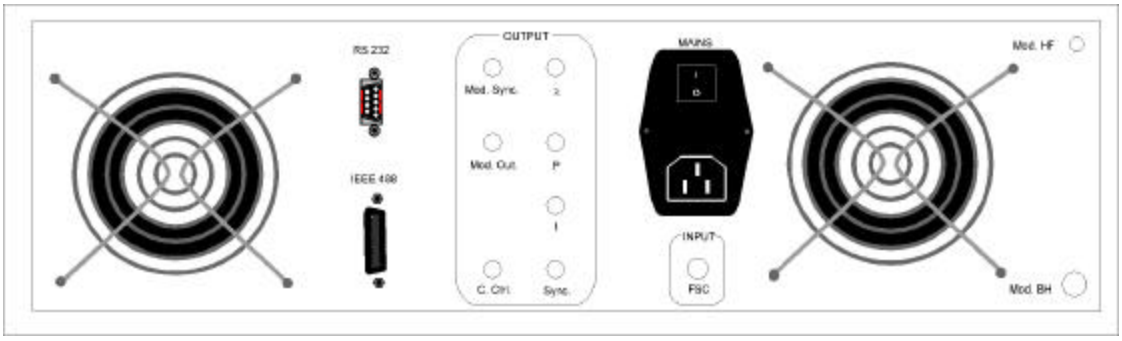

Figure 33: Tunable Laser Source Rear Panel

Receiver Front Panel

Figure 34 shows the front of the OWB10002 chassis. This component is a configurable chassis, in which a control module, detector modules, and configurable optical interfaces can be installed. Therefore, the front panel as shown is only typical.

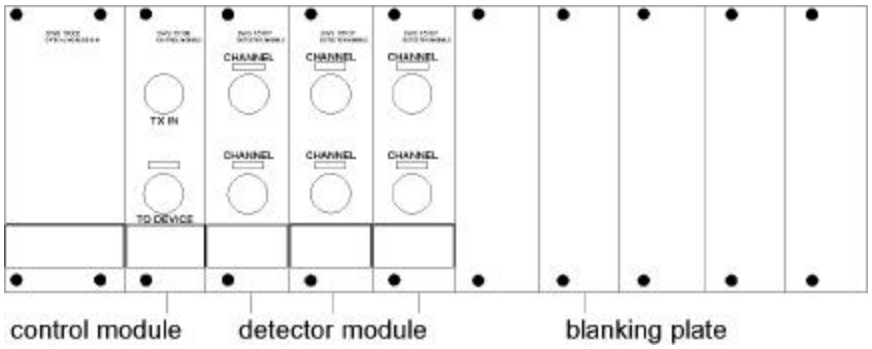

Figure 34: Receiver Chassis Front Panel

Receiver Rear Panel

Figure 35 shows the back of the receiver chassis. The IEEE 488 GPIB interface is not used for this application of the OWB1002 chassis.

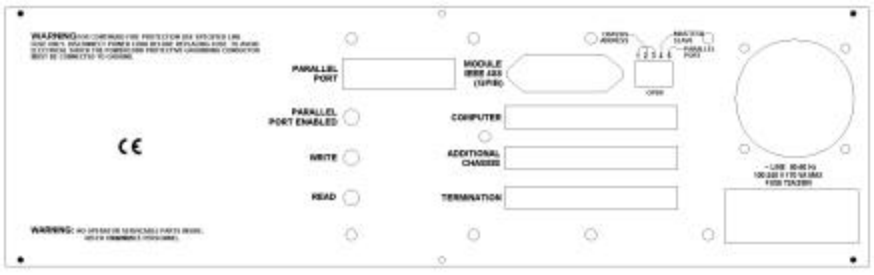

Figure 35: Receiver Chassis Rear Panel

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Compact Two-Channel Receiver Front Panel

The compact two-channel receiver, shown in Figure 36, is an option that can be used instead of the OWB10002 chassis or it can be used as the first chassis in a string of daisy-chained receiver chassis.

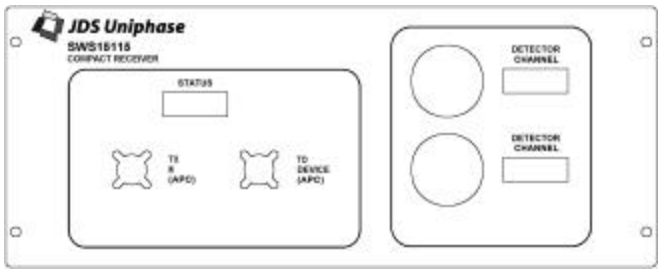

Figure 36: Compact Two-Channel Receiver Front Panel

Compact Two-Channel Receiver Rear Panel

Figure 37 shows the back panel of the compact two-channel receiver.

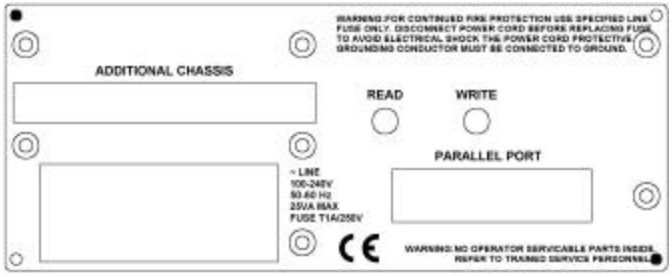

Figure 37: Compact Two-Channel Receiver Rear Panel

Control Module Front Panel

Figure 38 shows the front of the control module.

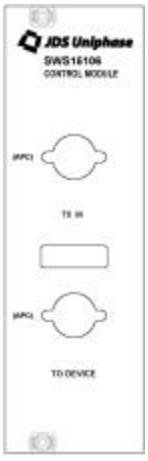

Figure 38: Control Module Front Panel

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Detector Module Front Panel

The front panel of the detector module is shown in Figure 39.

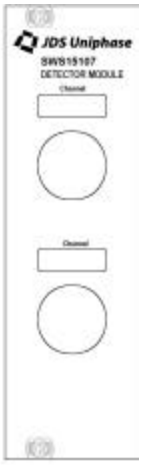

Figure 39: Detector Module Front Panel

Dual Band Selector Switch Module Front Panel

The DBSSM is an optional module that can be installed in the OWB10002 chassis. It permits the use of two transmitters with one receiver. Figure 40 shows the DBSSM.

Figure 40: Dual Band Switch Selector Module Front Panel

Four-State Polarization Controller Front Panel

The Four-State Polarization Controller, Model SWS15104 for C-band (Figure 41), is an optional component used to measure the PDL and the average loss of a wide range of passive optical components.

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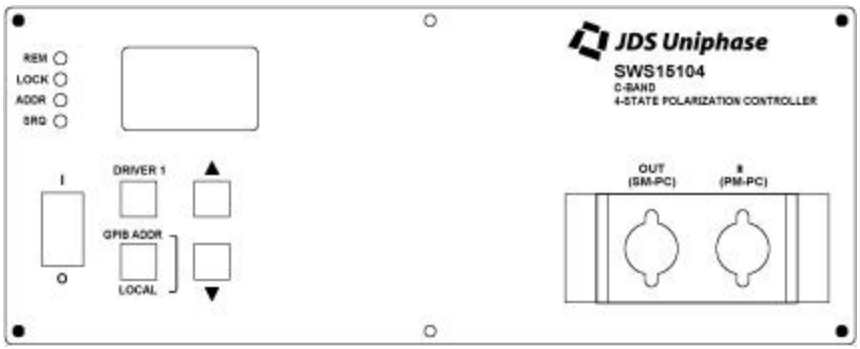

Figure 41: Four-State Polarization Controller Front Panel

Four-State Polarization Controller Rear Panel

The back of the controller is shown in Figure 42.

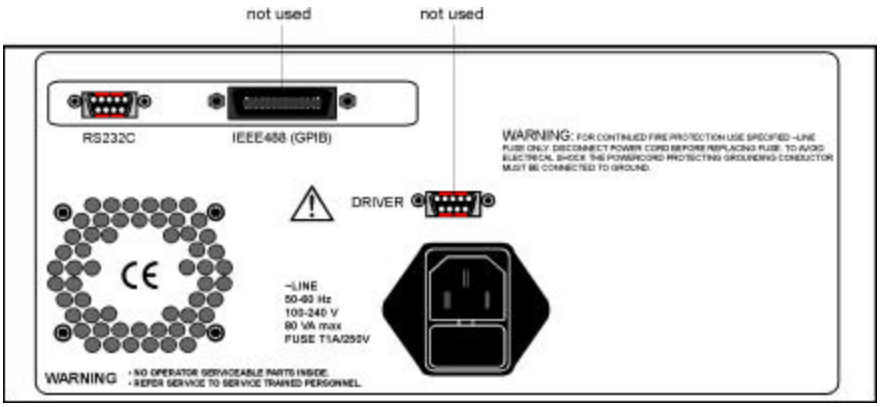

Figure 42: Four-State Polarization Controller Rear Panel

Setting Source Optics Module Parameters

Before using the SWS system, ensure that the SOM is properly set up to send the correct signals to the receiver control module. When the SOM is powered up, it initializes the laser and its own parameters. It also displays the version of firmware installed. After the firmware display, it automatically displays the main menu, from which the user selects the type of operation required.

Power-Up Screen

The SOM screen on power-up is shown in Figure 43. The screen is displayed after the SOM has been properly initialized.

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Figure 43: SOM Power-Up Screen

Main Menu

The main menu of the SOM is shown in Figure 44. The menu is used for selecting execution or setup parameters. The SETUP button is used to go to the Parameter Setup menu. To go to the menu used to set up the laser for manual operation, press the MANUAL button. The DISPLAY button is used to display the SOM intrinsic parameters, such as the serial number, the scan length, and the wavelength calibration constants.

Figure 44: Main Menu of the SOM

The SAVE button is used to save the current operational parameters.

Setup Menu

The parameter setup menu (Figure 45) allows the user to change operational parameters, including the start and stop wavelengths, the laser power, the scan rate, the delay between scans, and the polarization mode. To change a parameter, such as the laser power, press the button beside POWER.

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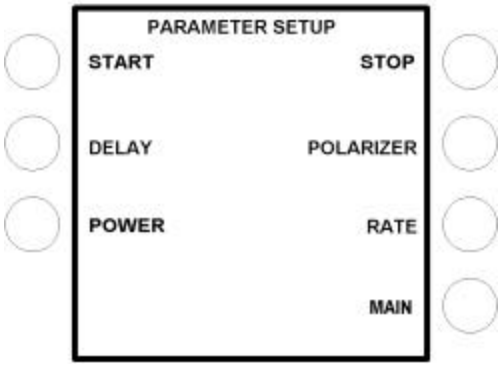

Figure 45: Setting SOM Parameters

A new menu appears, as shown in Figure 46. The arrows are used to select the value of the parameter. The UP and DOWN buttons are used to increase or decrease the digits of the value. Using the buttons, the value of the selected parameter can be changed within the limits set for the laser. When the correct value is displayed, press the BACK button to return to the previous menu.

Figure 46: Changing Parameter Values

In each menu where values can be changed, the NEXT button is used to select the parameter to modify. Repeatedly pressing the NEXT button moves a large arrowhead through all parameters. To increase the value, press the UP button, and to decrease the value, press the DOWN button.

Manual Menu

The manual mode, shown in Figure 47, can be used to check the wavelength and power outputs of the laser. When the correct value is selected, press the SET button.

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Figure 47: Manual Mode Settings on the SOM

In manual mode, the laser power and wavelength can be set to any value, the laser can be enabled or disabled, and the four-state polarization controller can be manually controlled. The procedure for setting the wavelength or power of the laser is similar to that for setting the system parameters. Press the POWER button to set the power. The following menu, shown in Figure 48, appears. The button marked RELAY is for future expansion. Do not use this option.

Figure 48: Setting Parameters in Manual Mode

Select the value of the parameter and press SET. Press the BACK button to return to the previous menu. POWER must be enabled to apply the parameter values to the laser.

Remote Option

The REMOTE button on the SOM main menu is used to change the GPIB address of the SOM. The button is used only if the SOM is being controlled through a GPIB master. It can be used to set parameters, or execute the SOM, using remote control. When the REMOTE button is pressed, the display is updated as shown in Figure 49.

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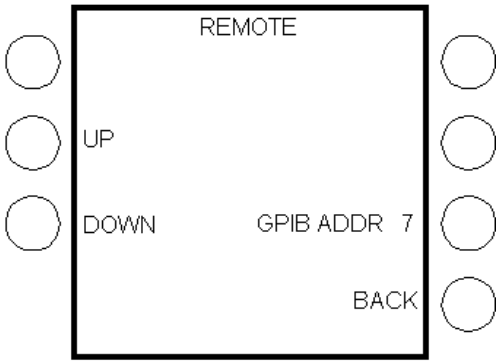

Figure 49: Remote Option on the SOM

The REMOTE menu also displays the type of laser selected. Do not change this field.

Display Option

When the DISPLAY button on the main menu is pressed, some important system parameters for the SOM are displayed, as shown in Figure 50. The parameters include:

- Serial number of the SOM
- Number of points in a trace. The number can be used to set the MaxPoints in the SWS15100.INI file.
- Value of M_O, one of the wavelength calibration constants
- Value of L_O, the other wavelength calibration constant

Figure 50: Display Option on the SOM

The other constants displayed are currently not used.

Source Optics Module Operation

During SOM operation, the display is updated to show the current operating conditions. When the laser is commanded to scan, dots are added to the bottom line of the screen, which creates a moving display, as shown in Figure 51. The display indicates that the SOM is operative. If the dots do not appear, or do not change, the SOM is not operating correctly. Error messages are displayed on the same line and remain on the screen until a button is pressed.

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Figure 51: SOM Status Display

The first line displays the heater status. The SOM requires the heater to be STABLE for proper operation. The second line shows a track voltage, which changes during a scan. The remaining parameters are set by the user. The Polar variable shows the current polarization state.

Using SWS Software

This section describes the capabilities of, and the procedures for using, the SWS15100 application software. Figure 52 shows a sample directory listing of the SWS15100 directory, after the software is installed. The executable file is SWS15100.exe. The files OWB1.DLL, OWB2.DLL, and OWB3.DLL are required for program execution. Utilities provided include SOMAccess.exe and testcount.exe. These files are described later in this section. The Development folder contains the Visual Basic (VB) and C++ examples and the SWS15100 DLL, which can be used for the development of specialized application packages.

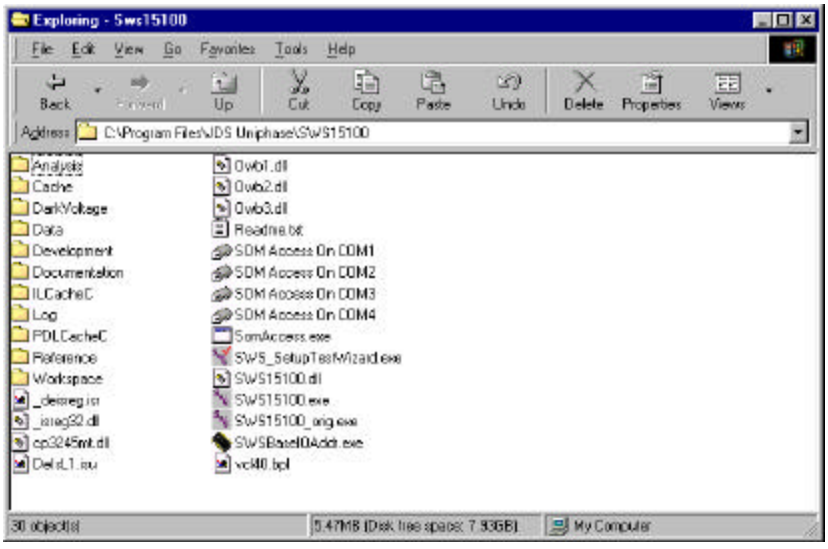

Figure 52: Components of SWS15100 Software

SWS Program

The SWS software can be run from the start menu, or from the desktop if a shortcut is copied to it. To execute the program, a number of parameters must be selected first. The menu allows the

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proper selection of required parameters. The software can operate in one of two modes: insertion loss (IL) or polarization dependent loss (PDL). The user must select one of these. The polarization mode must also be selected.

SWS User Interface Main Menu

When the program is executed, a window, similar to the one shown in Figure 53, is opened. The top of the window displays the menu items (File, Mode, System, and Help) that are available for controlling the execution of the SWS.

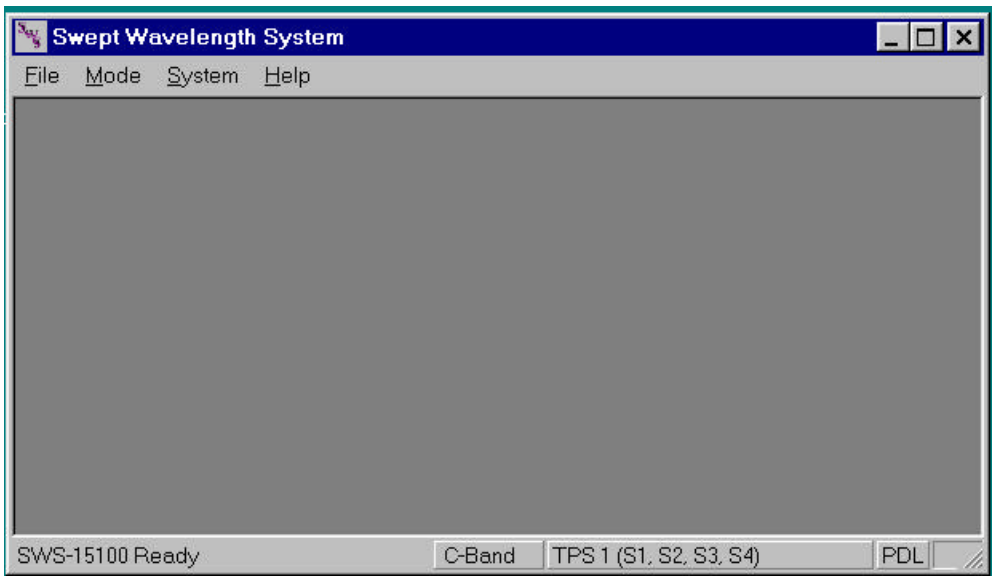

Figure 53: SWS15100 Main Program Window

File Menu

The File menu is shown in Figure 54.

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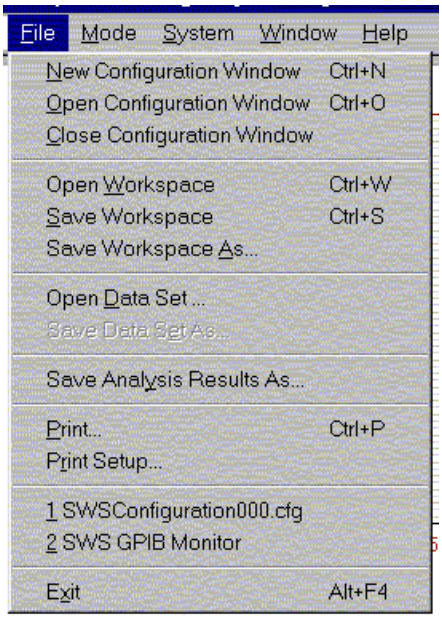

Figure 54: File Menu

The File menu provides the user with the file selection and control capabilities. The menu items are:

New Configuration Window—creates a new configuration window with a blank chart, blank analysis window, and blank channel list. Open a new configuration window when the SWS window is blank or when a new window is needed in additional to those already opened. Each configuration window can handle any number of channels and various processing and analysis modes.

Open Configuration Window—opens a previously saved configuration window. All previously saved settings are used.

Close Configuration Window—closes the current configuration window. The software prompts the user to save the configuration window file. If the file is saved, the user is prompted for the file name under which the file is to be saved. The selected channels, data acquisition mode, processing mode, analysis settings, display options, and data storage options are saved.

Open Workspace—opens a previously saved test configuration. The workspace comprises all windows needed to measure a particular type of device.

Save Workspace—saves the settings of the current test configuration with the name previously assigned. When a workspace is saved, all the configuration windows, with their associated parameters, are saved as part of the workspace.

Save Workspace As—saves the settings of the current test configuration with a new user-specified name.

Open Data Set—opens a previously saved set of measurement data and recreates the data plot in the Plot area in the top half of the main window.

Save Data Set As—saves the measurement to a text (.txt) file in the format specified by the user. The user can select or specify the following formatting parameters:

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- Save data by range, either wavelength or frequency
- Customize the amount of data stored by saving all data points, saving every n^{th} point, or averaging n points
- Add a user comment to the file and store it in the file header
- Organize the data within the file by specifying whether to combine all channels or use one file per channel
- Save data in binary format to save space on the disk, or in ASCII format to export to other analysis programs
- Save Mueller matrix data and save all traces or only those displayed
- Save the file by name

When this menu item is selected, a dialog box, shown in Figure 55, is displayed.

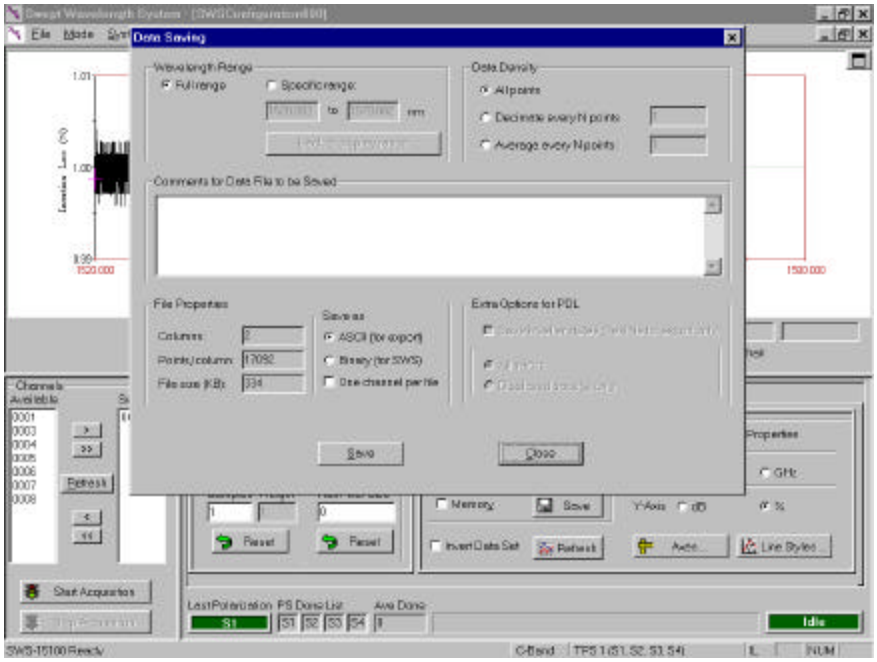

Figure 55: Dialog Box to Save Data Set

Save Analysis Results As—saves the measurement data that is in the Analysis area to an external text file. The user is prompted for the file name under which the file is saved.

Print—opens a dialog box containing two check boxes that provide the user with the option to print the Analysis Grid, the Channel Graph, or both. After the user checks one or both of these boxes and clicks the OK button, the software prints the specified portion(s) of the screen.

Print Setup—opens the standard Windows Print Setup dialog box that allows modification of several printing parameters.

Recent File—displays a list of the most recently accessed files.

Exit—exits the program.

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Mode Menu

The Mode Menu, shown in Figure 56, allows the user to set the wavelength band, the polarization state to expect from the transmitter, and the processing mode. The default processing mode is PDL. For this mode, the transmitter polarization state must be 1. Ensure that Polarization Mode 1 is selected on the source optics module.

Figure 56: Mode Menu

Band—selects the type of data to be processed which can be C-band, L-band, or a combination of both. The selection must match the hardware available. Select C-band to have only a C-band SOM, L-band to have only an L-band SOM, and C+L-band if both SOMs and a Dual Band Selector Switch Module are installed.

Transmitter Polarizer State—for PDL measurements, the default is four PDL states (S1 to S4). If a polarization controller is not installed, select mode 0, which is S0. The transmitter polarization states that are available with a polarization controller, as a function of the selected mode, are listed in Table 12. The individual polarization states are defined in Table 13.

Table 12: Polarization Modes

Mode	S0	S1	S2	S3	S4
M0	✓				
M1		✓	✓	✓	✓
M2			✓	✓	✓
M3		✓		✓	
M4		✓			✓
M5			✓	✓	

Table 13: Polarization States

Polarization State	Description
S0	Circular polarization at the output of the polarization controller. If there is no controller, the polarization is linear (90°).
S1	Circular polarization with +3 dB loss
S2	Linear (0°) polarization
S3	Linear (90°) polarization

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S4	Linear (-45°) polarization

Insertion Loss—puts the SWS in insertion loss mode for IL measurements. When IL mode is selected, the polarization mode can also be selected.

PDL—puts the SWS in PDL mode, which is the default mode, for PDL measurements. In PDL mode, the polarization mode is set to M1. The mode cannot be changed by the user.

System Menu

Figure 57 shows the System menu.

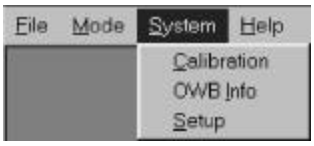

Figure 57: System Menu

The user is given three options on the System menu: Calibration, OWB Info, and Setup.

Calibration—opens the calibration window. See the **Calibrating the Equipment** section for detailed calibration procedures.

OWB Info—refers to information stored in the control module and detector modules. The CM stores wavelength and power calibration constants, while the DMs store only power calibration constants. Other information is stored, including part and revision numbers, and serial numbers. When the user selects this option, the information is read from the receiver modules and displayed (Figure 58).

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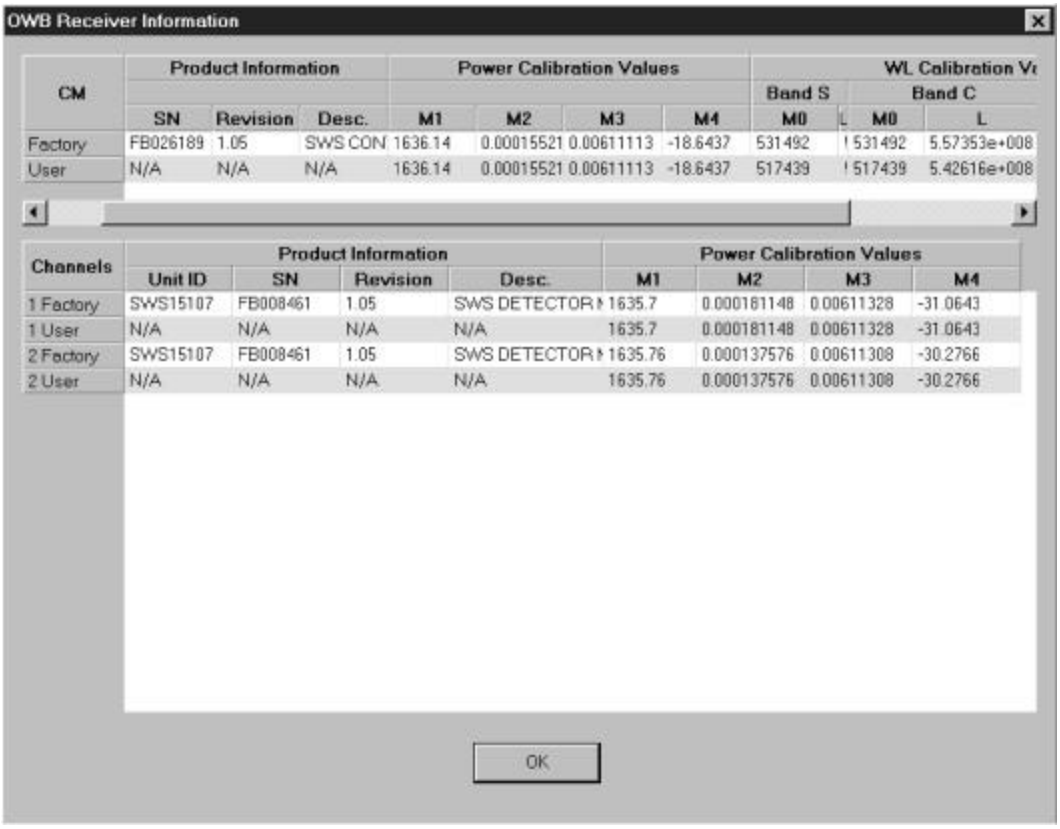

Figure 58: OWB Info Option

Setup—refers to the setup of data transfer hardware, the switch configuration, and parameters in the SWS15100.INI file. The Setup option displays a dialog box with three option tabs: General Setup, Switch Setup, and System Setup.

General Setup

General Setup allows the user to enable or disable the wavelength diagnostics for each available band and to set parameters to fine tune the diagnostics. The user can also change the number of points in a trace for each band. The General Setup option is shown in Figure 59.

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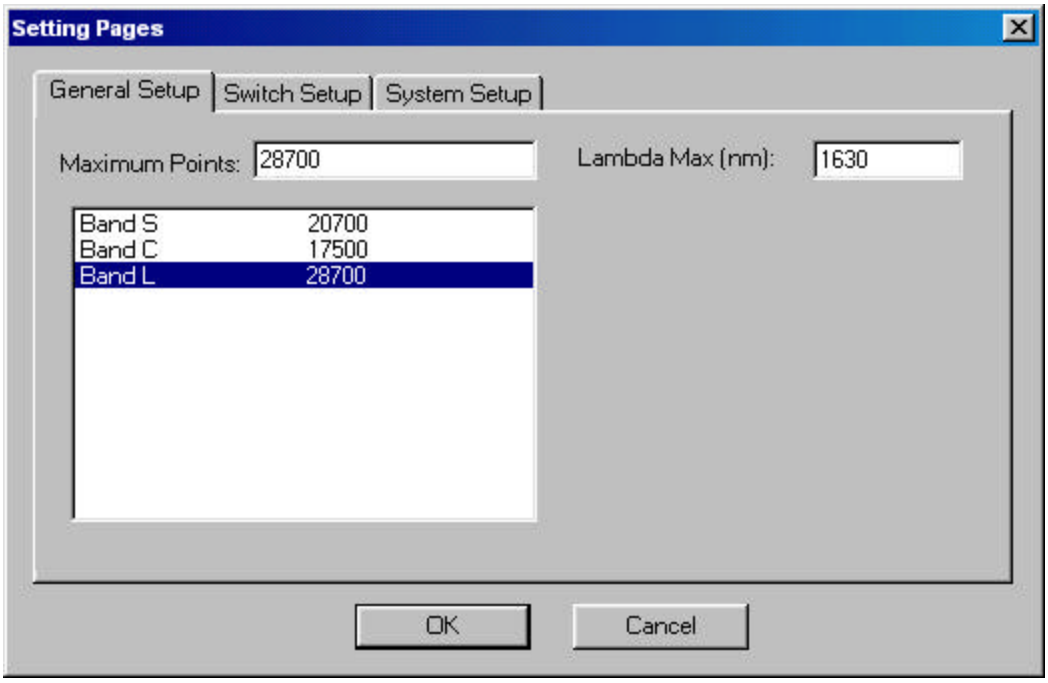

Figure 59: General Setup Tab

Switch Setup

Switch Setup allows the user to set the switch configuration. The default settings for the SWS are: TX1 for C-band, TX2 for L-band, and Output is to the control module. The Switch Setup option is shown in Figure 60.

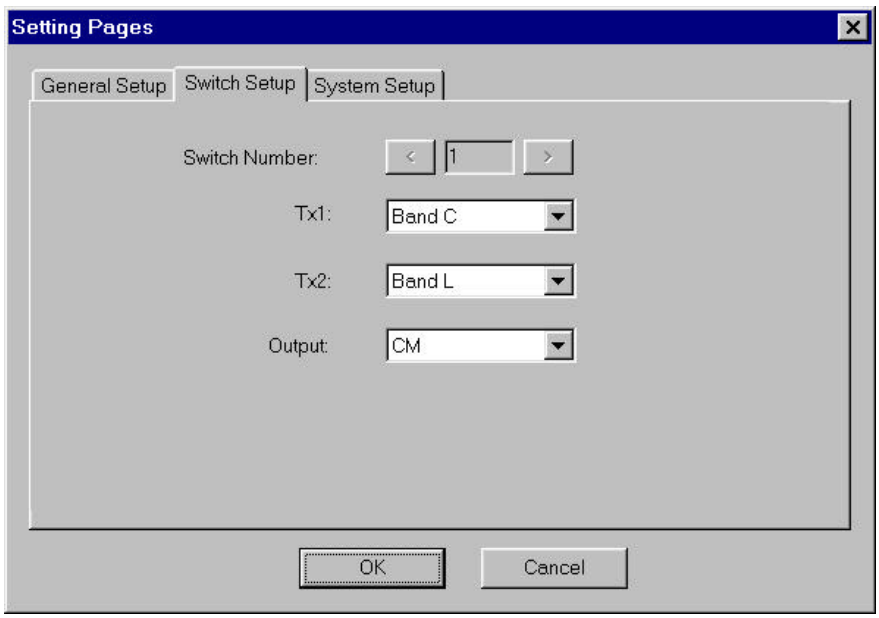

Figure 60: Switch Setup Tab

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System Setup

System Setup allows the user to set up SWS parameters, such as the points in a trace for each band. The dialog box that is displayed is shown in Figure 61. Changes made with this option are reflected in the .INI file and are used for running the SWS at a later time.

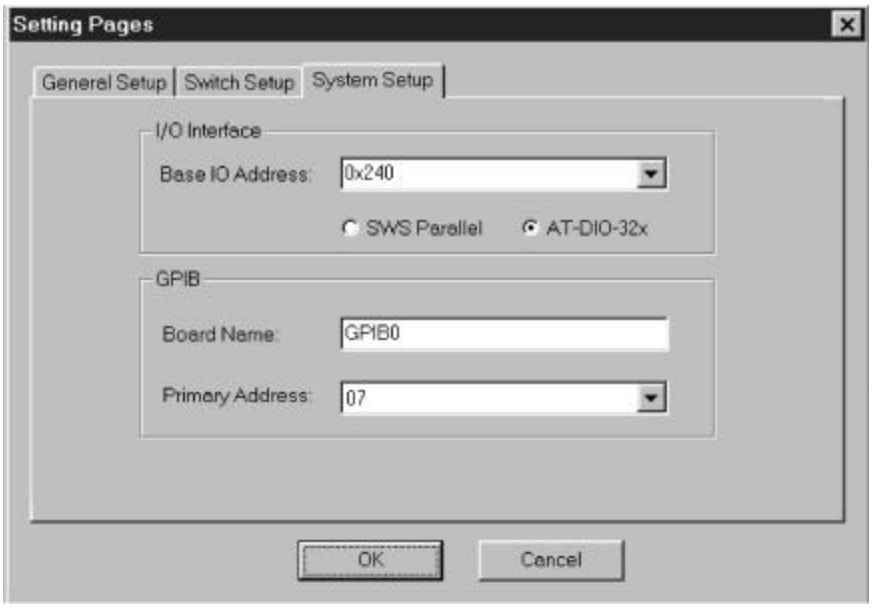

Figure 61: System Setup Tab

Window Menu

Figure 62 shows the Window menu.

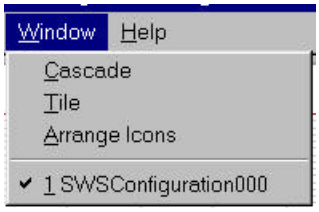

Figure 62: Window Menu

Cascade—arranges all open windows, slightly overlapping, from the top left to bottom right of the window.

Tile—arranges open windows either horizontally or both horizontally and vertically, whichever best fits the screen.

Arrange Icons—arranges the icons representing all minimized windows by lining them up beginning at the bottom left corner of the screen

<Window list>—the bottom section of the Window menu, which provides the name of each of the active windows, to a maximum of nine configuration window entries. If more than nine configuration windows are open, the More Windows option appears in the last line of the Window menu.

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More Windows—displays a list box of all open configuration windows, from which the user can select those to view. This option is displayed only when required.

Help Menu

Figure 63 shows the Help menu.

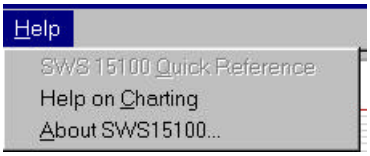

Figure 63: Help Menu

SWS15100 Quick Reference—currently disabled.

Help on Charting—provides help on modifying parameters associated with the plot area.

About SWS15100—displays a dialog box with program name, version, and copyright information.

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Configuration Windows

When the program is run for the first time, it is necessary to open a new configuration window from the File menu item. Figure 64 shows an example of the main configuration window. It is comprised of the Chart Area in the upper half of the screen, the Common Area in the bottom left of the screen, and the Status/Analysis Area in the bottom right of the screen.

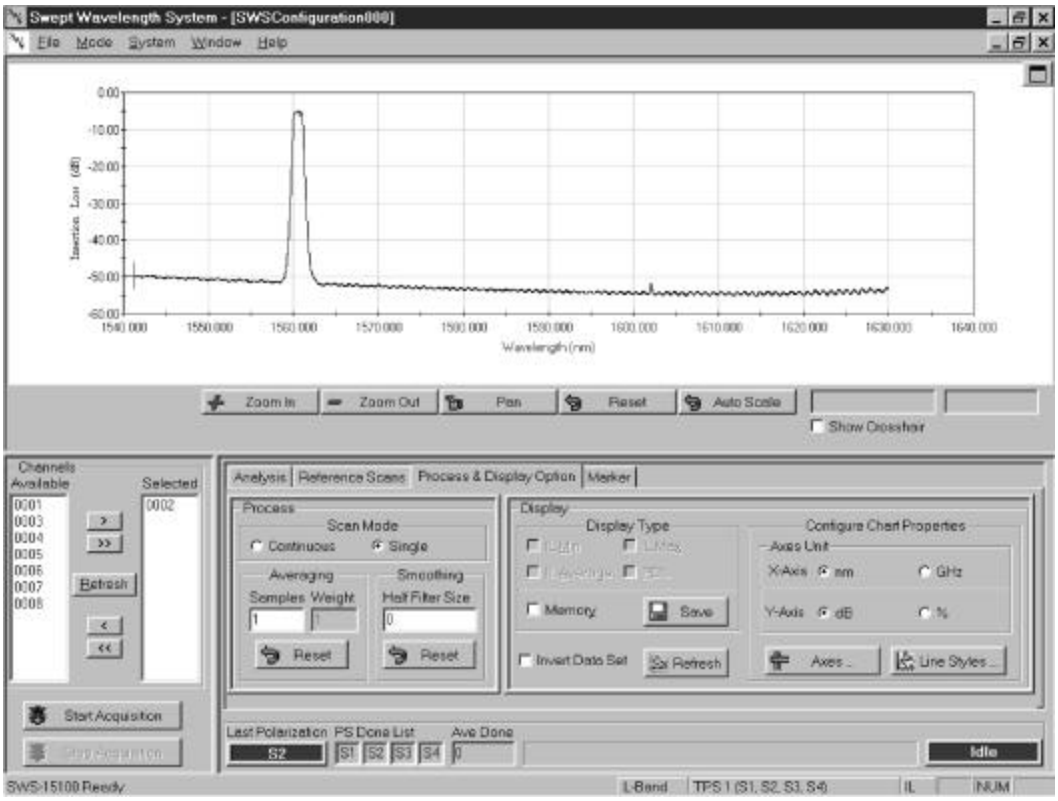

Figure 64: Configuration Window

Each area is described in more detail. Also provided are instructions on how to control the acquisition, processing, analysis, and display of the data by using controls in each of these areas.

Chart Area

When data is collected and processed, plots of the computed IL or PDL are displayed as a function of the wavelength and frequency. The plots are shown in the Chart Area. Controls and key options are provided to manipulate this image.

Window Separator

A window separator is provided to expand or contract the height of the chart area. The 3D raised line can be moved up or down by clicking it and dragging it to where desired. This action changes the vertical scale of the plot.

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Maximize Button

The Maximize button is located in the top right-hand corner of the Chart Area. If the button is clicked, the plot is expanded to fill the screen. If the button is clicked again the plot returns to its former size.

Zoom In

Pressing the Zoom In button causes the plot to expand. The center of the image is left unchanged, but both the x-axis and y-axis scales are reduced to a smaller range.

Zoom Out

The Zoom Out button does just the opposite of the Zoom In button. The ranges of both the axes are increased and the image is made smaller. The center of the image is left unchanged.

Pan

The Pan button is used to move the image without changing the scale. Click the left mouse button on the center of the new image. Next, click the Pan button. The image is moved so that the desired location is at the center of the plot. Clicking the Pan button again results in the image moving by the same amount as before.

Reset

The Reset button is pressed to change the plot scales to fixed values. This button is used to return the image to a standard scale.

Autoscale

Pressing the Auto Scale button redraws the plots with the most suitable scales for both y-axes. All data is then displayed at the highest resolution.

Crosshairs

The crosshair feature, enabled by checking the Show Crosshair check box, displays the coordinates in the boxes to the right of the check box.

Common Area

The Common area of the configuration window, shown in Figure 65, is for channel selection and to acquire new data and references.

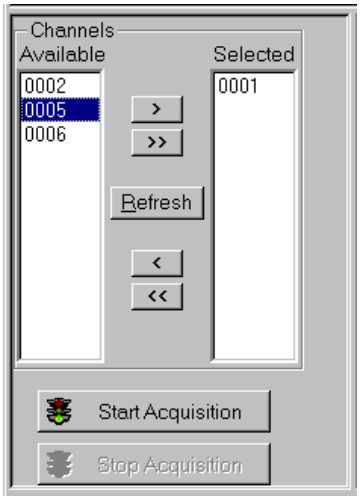

Figure 65: Common Area

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Channel Selection

All available channels are shown in the list on the left of the screen. To select all channels, press the >> key. To deselect all channels, press the << key. To select a particular channel, highlight the channel in the list on the left and press the > key. To highlight one or more channels from the list box, use a combination of the <Shift> or <Ctrl> key and the left mouse button or the arrow up or down key. The channel is moved to the list on the right. To deselect a channel, highlight it in the list on the right and press the < key.

Channels must be selected to make any measurements on devices attached to them. Also, analysis can be performed only on selected channels.

If the selected channel does not appear on the list, click the Refresh button. The list of available channels is updated.

Stopping and Starting Acquisition

The Start Acquisition and Stop Acquisition buttons are for collecting or stopping the collection of new data.

Status/Analysis Area

The Status/Analysis area, shown in Figure 66, is used to display the status of the system, as well as the current value of important system parameters.

Figure 66: Status Area

The status area contains the following text boxes:

- Last Polarization State—displays the last polarization state acquired. Valid polarization states that appear in the text box are S0, S1, S2, S3, S4, and Unknown. Unknown appears when the Start Acquisition button is first clicked or when the Last Polarization State is out of range.
- Polarization Done List—used for PDL and averaging. The Polarization Done List is not available in Insertion Loss Mode, except in the averaging and the reference measurement.
- Average Done Count—used only for averaging. This box displays the number of traces averaged.
- Progress bar—displays square boxes along the bar when the system is collecting data.
- Status—displays the status of the system with parameters such as:
    - Idle—when the SWS is not doing anything significant
    - Progress—when data is collected
    - Display—when data is processed for display on the screen

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Reference Scans Tab Page

The Reference Scans tab page (Figure 67) is used to control the acquisition of references.

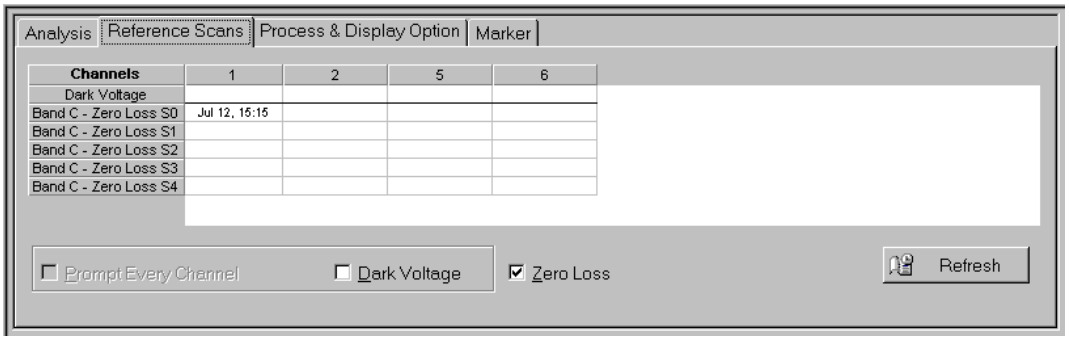

Figure 67: Reference Scans Tab Page

The Reference Scans tab page contains the Reference Table, the Dark Voltage measurement check box, the Prompt Every Channel check box, and the Zero Loss Measurement check box.

Each of six rows in the Reference Table represents a reference measurement for Dark Voltage and Zero Loss for polarization states S0 to S4. The columns are for the channels. The value in each white cell is the time-stamp at which the measurement took place. To display the absolute power in dBm for the channel belonging to that column, move the mouse over a Dark Voltage or Zero Loss cell in any column.

Performing Dark Voltage Measurement

To perform a dark voltage measurement:

1. Ensure that all required channels are listed in the Selected column.

2. Turn on the dark voltage measurement by checking the Dark Voltage check box.

3. Check the Prompt Every Channel check box to do the dark voltage measurement individually for all channels. This check box applies only to the dark voltage measurement; therefore, it is disabled if the Dark Voltage check box is not checked. If Prompt Every Channel is checked, the dark voltage measurements are taken for one channel for each scan. Otherwise, the dark voltage is measured for all selected channels in one scan. This prompt is used when performing both dark voltage and zero loss measurements at the same time.

4. To measure only dark voltage for a number of channels, do not check this box.

5. Press the Start Reference button. The program prompts the user to put a detector cap on each channel on the receiver for the dark voltage measurements.

6. Use the detector caps supplied with the receiver to cap the detectors and then click OK. A dark voltage measurement is taken and the results are stored and used for all subsequent power measurements.

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Performing Zero Loss Measurement

Performing a zero loss measurement, or reference, is similar to the dark voltage measurement, except that the Zero Loss check box must be checked. References are made one channel at a time. The software prompts the user to connect a jumper between the output of the Control Module and the channel of interest.

Press the Start Reference button to acquire the reference.

References are best taken after the system has warmed up. After warm-up, it is recommended that all measurements be taken for one channel before moving on to the next channel. This procedure, which reduces the number of times re-connections are made, is preferable to taking a reference for each of the channels and then acquiring a reference for each of the channels.

For greater stability of polarization and to avoid drift:

1. Take a reference on the first channel.
2. Acquire the reference for the first channel.
3. View the reference in the Chart area to confirm that it is acceptable.
4. Move the jumpers, if necessary, to the next channel for reference and acquisition.

Process and Display Options Tab Page

The Process and Display Options tab page (Figure 68) allows the user to select both data processing and data display options.

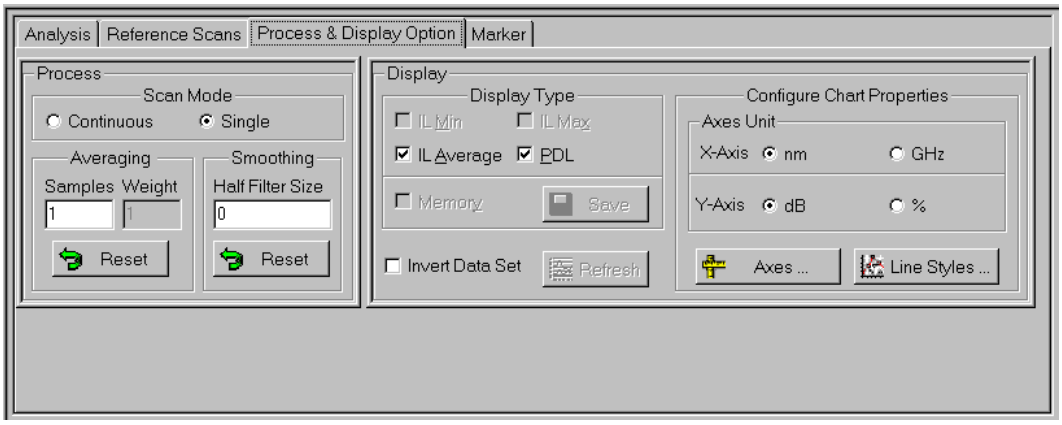

Figure 68: Process and Display Page

Scan Mode

Two types of scanning are available in the SWS—single and continuous. In single scan mode, one scan is performed and the result is displayed. When the scan is complete, the system returns to the IDLE state. In continuous mode, the data is acquired, processed, and displayed for each scan. Then new traces are acquired. The data acquisition and display stops only when the Stop Acquisition button is pressed.

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Averaging

Successive traces can be combined to average the results. In IL mode, successive traces are combined without reference to the polarization state. In PDL mode, traces are averaged for each of the polarization states individually. The result of averaging is to reduce the effects of white noise.

To enable averaging, the user enters the weight and number of samples. The weight of the latest sample is also required. See the **Averages** paragraph in the **How the SWS Calculates Values** section for information on how the averaging is implemented.

Smoothing

Smoothing applies a triangular filter to the data. If the half size chosen for smoothing is n, the power at any point k is:

$$P(k) = \sum \frac{P(k+r)\ (n+1-|r|)}{(n+1)^2}$$

where P(k) is the power at point k. The sum is for values of r, from -n to +n, for a half filter size of n.

The effect of smoothing is to average noise over a few wavelengths. It reduces the wavelength resolution. Use smoothing with care for devices in which the insertion loss changes rapidly with wavelength.

Display Type

The display type that can be selected depends on the processing mode. In IL mode, only the insertion loss can be displayed. However, in PDL mode, there are four possibilities: PDL, minimum IL, maximum IL, and average IL. Any two can be selected at one time.

- The minimum IL plotted is the minimum insertion loss at each wavelength for all possible polarizations of the incident light as it passes through the device. The minimum is computed from the Mueller matrix, which in turn is derived from the insertion measurements for the four polarization states that are the output of the polarization controller. The quantities are computed from the Mueller matrix elements for each wavelength.

- The maximum IL is the maximum insertion loss, without respect to the polarization state of the input to the device.

- The average IL is the average insertion loss over all possible polarization states of the input to the device.

- The PDL is the difference between the maximum and minimum insertion losses.

After the selection is made, click the Refresh button to change the display.

Saving a Trace to Memory

A trace that is displayed on the chart can be saved to memory. Press the Save button to save the trace to memory. Only one trace is saved and the previously saved trace is overwritten.

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Retrieving a Trace from Memory

To view a trace that is saved to memory, click the Memory checkbox and press the Refresh button. The trace appears on the chart. Press the Reset button or Autoscale button in the Chart area to redraw the plot, if necessary.

Inverting a Data Set

A data set can be inverted; that is, all power values can be changed in sign, by clicking the Invert Data Set check box, and then clicking Refresh.

Overlaying a Trace

A previously saved trace can be overlaid onto the currently displayed trace. To perform an overlay, save a trace as explained in the **Saving a Trace to Memory** section. Acquire a new trace to display, or load a data set that has been stored previously. See the **File Menu** section for details on saving a data set. When the new data is shown on the chart, click the Memory check box, ensure that it is checked, and click the Refresh button. The old data is now superimposed over the current trace.

Chart Properties

The SWS software allows the user to select the units used for the x-axis and y-axis. Click the radio button for the desired units in the Configure Chart Properties section of the Process and Display Options tab page.

- The units for the x-axis can be either wavelength (nm) or frequency (GHz).
- The units for the y-axis can be either linear (%) or logarithmic (dB).

Changing Scales on the Plot Axes

The scale factors used to display the acquired traces can be changed easily. To change the parameters for the axes, press the Axes button on the Process and Display Options tab page. A dialog box appears, as shown in Figure 69. Use this dialog to change the minimum displayed value, the maximum displayed value, and the origin.

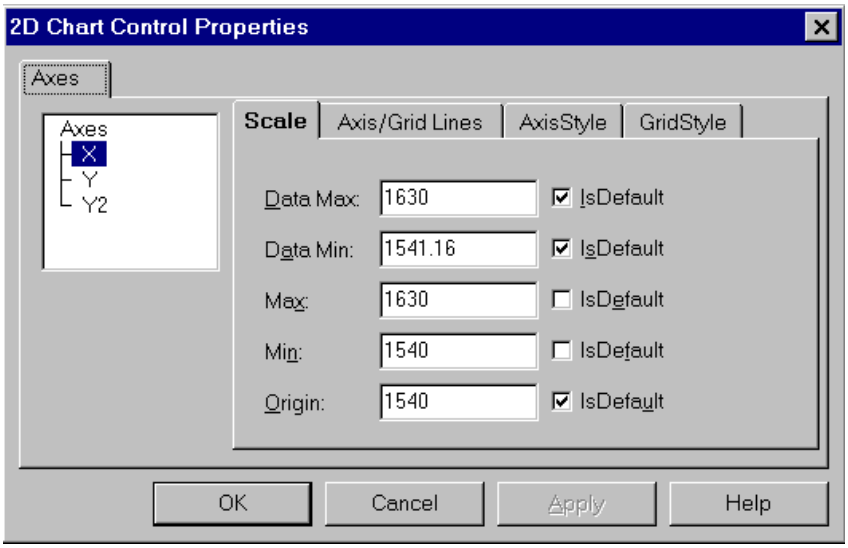

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Figure 69: Dialog Box to Modify Axis Properties

Selecting Chart Line Styles

Press the Line Styles button in the Process and Display Options tab page to display a dialog box, shown in Figure 70. This dialog can be used to change the line thickness, the line style, and color of any trace. Select modifications from those displayed and click the Apply button to view the changes.

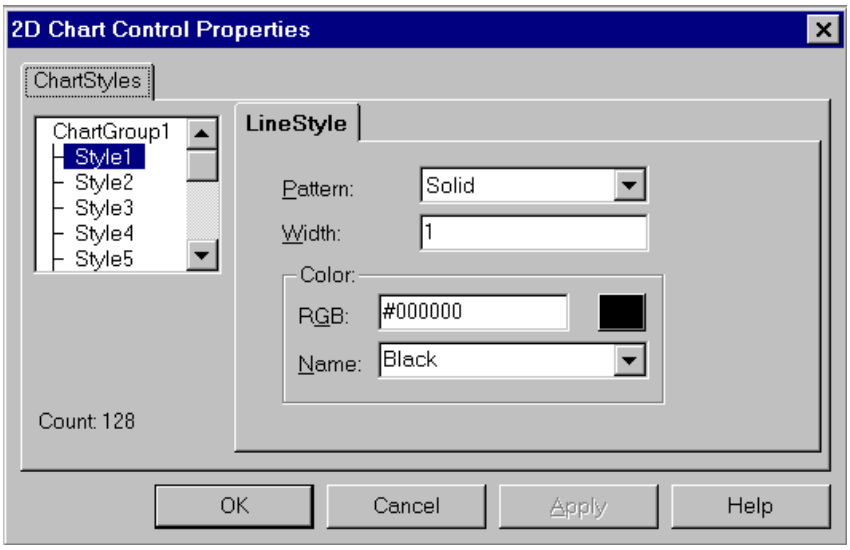

Figure 70: Dialog Box to Modify Trace Properties

Analysis Tab Page

The SWS software provides flexible analysis capabilities. The Analysis tab page is used to specify the ITU or other channels and the types of analyses to be performed on them. The results of the analyses are presented in tabular form, with each row corresponding to a physical channel on the receiver.

Each column is reserved for a particular parameter that is analyzed. The parameters that can be calculated and presented are:

- Center wavelength
- Bandwidth
- Passband
- Crosstalk
- Flatness
- Maximum and minimum peaks

The parameters can be measured in specified wavelength channels, either ITU or user-defined. For some parameters, the threshold, or power level at which they are calculated, can be set by the user. Threshold is required for bandwidth, center wavelength, and passband calculations.

The Analysis area is at the bottom left of the main window, shown in Figure 71, and appears as a read-only spreadsheet. The software performs basic analysis on the data being viewed in the

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plot area and places the data in this location. All data found in any one row is specific to one channel. Each parameter value, if applicable, has an assigned column stored in a specific column.

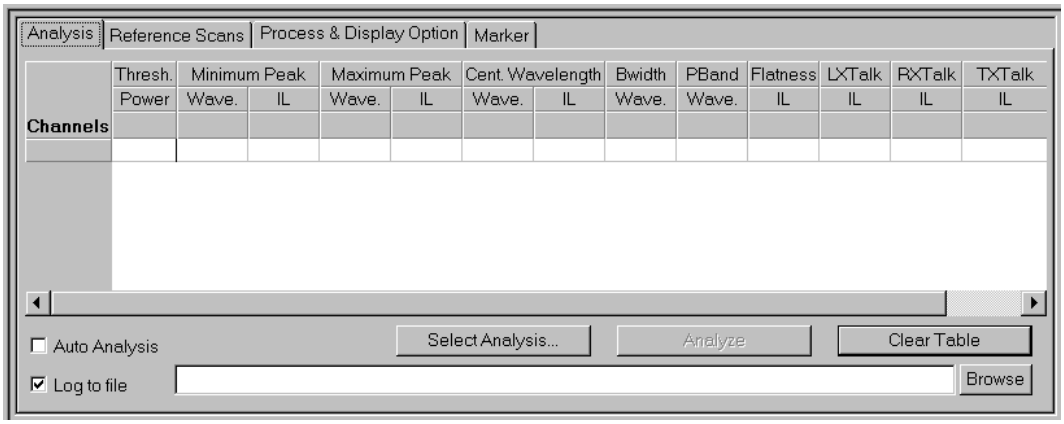

Figure 71: Analysis Tab Window to Display Analysis Results

The Analysis tab page shows the channels selected for analysis and computed parameters for each of the channels. There are one or two columns under each heading. The columns are:

Threshold Power—shows the power level, below the peak or above the base, at which the parameters are computed.

Minimum Peak—two columns show the wavelength at which the minimum peak occurs and the insertion loss at that wavelength.

Maximum Peak—two columns show the wavelength at which the maximum peak occurs and the insertion loss at that wavelength.

Center Wavelength—two columns show the center wavelength and the insertion loss at that wavelength.

Bandwidth—the column shows the computed bandwidth. If a peak has multiple bandwidths at a specified threshold, the value shown is the minimum bandwidth.

Passband—the column shows the computed passband.

Flatness—the column shows the computed flatness between two specified wavelengths. The flatness has the same units as insertion loss.

LXTalk—the column shows the crosstalk in the channel immediately to the left of the reference channel.

RXTalk—the column shows the crosstalk in the channel immediately to the right of the reference channel.

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TXTalk—the column shows the total (also called “cumulative”) crosstalk in all specified channels adjacent to the reference channel. The channels to include are all the ITU channels included in a specified wavelength range.

See the **How the SWS Calculates Values** section for explanations of the methods used to calculate these values.

A set of checkboxes and buttons, which enable the user to control the analysis, are below the table of computed parameters.

Auto Analysis Checkbox—when checked, the table is updated every time a new scan is acquired.

Log to File Checkbox—when checked, the table is written to a specified file every time the table is updated. The name of this file is shown in the adjacent text box and can be changed using the standard Browse button.

Select Analysis Button—used to select the type of analysis. When this button is pressed, a dialog box is displayed (Figure 72).

Analysis Definition File

Analysis is performed from a predefined analysis definition file (ADF) or by creating a new file. The following is an example of an ADF file:

```
UnitsX      0
UnitsY      0
ITUspace    100
CITUListType      1
CITUStartWavelength     0.000
CITUStopWavelength      0.000
CITUListSize      0
<CITUListBegin>
<CITUListEnd>
Comments    This is an example of an analysis definition file
Date/Time   May 24,2000, 16:05
Record#     Enable      Ch    Min   Max   BW/CW StartWL     StopWL      RefP
      BRef  Thld  Mrks  RefWL FtSize      PBand PBtld Ftness      FRange
      XTalk XTRange     CumXTalk    Comments
1     1     002   1     1     1     1541.158    1630.000    0     0     0.500
      0     0     0     0     0.500 0     Bandwidth   0     0.500 0     None
2     1     003   1     1     1     1541.158    1630.000    0     0     0.500
      0     0     0     0     0.500 0     Bandwidth   0     0.500 0     None
3     1     004   1     1     1     1541.158    1630.000    0     0     0.500
      0     0     0     0     0.500 0     Bandwidth   0     0.500 0     None
4     1     005   1     1     1     1541.158    1630.000    0     0     0.500
      0     0     0     0     0.500 0     Bandwidth   0     0.500 0     None
5     1     001   1     1     1     1541.158    1630.000    0     0     0.500
      1     0     0     0     0.500 0     Bandwidth   0     0.500 0     None
```


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CITUStartWavelength, CITUStopWavelength, CITUSize, <CITUListBegin>, and <CITUListEnd> are parameters required for crosstalk calculation. Click the Setup button for ITU channels.

Analysis definition files can be set up once, for any number of channels, and reused on any receiver, without regard to channels selected. The analysis is performed for only the channels that exist.

Basic analysis includes finding the minimum and maximum insertion losses, finding bandwidth and center wavelength, turning markers on or off, and finding peaks. The analysis can be performed in a selected wavelength or frequency range.

The advanced analysis section allows the user to add a comment to the analysis, provides selections to compute passband, flatness, crosstalk, and cumulative crosstalk, and sets up ITU channels used in the analysis.

The analysis definition file must be saved, or an old analysis definition file loaded, before analysis can be performed.

Setting the Analysis Parameters

Before conducting analysis on the data, the analysis parameters in the Analysis Setup dialog box must be defined. Open the Analysis Setup Dialog Box by clicking the Select Analysis button on the Analysis tab page. This dialog box is shown in Figure 60.

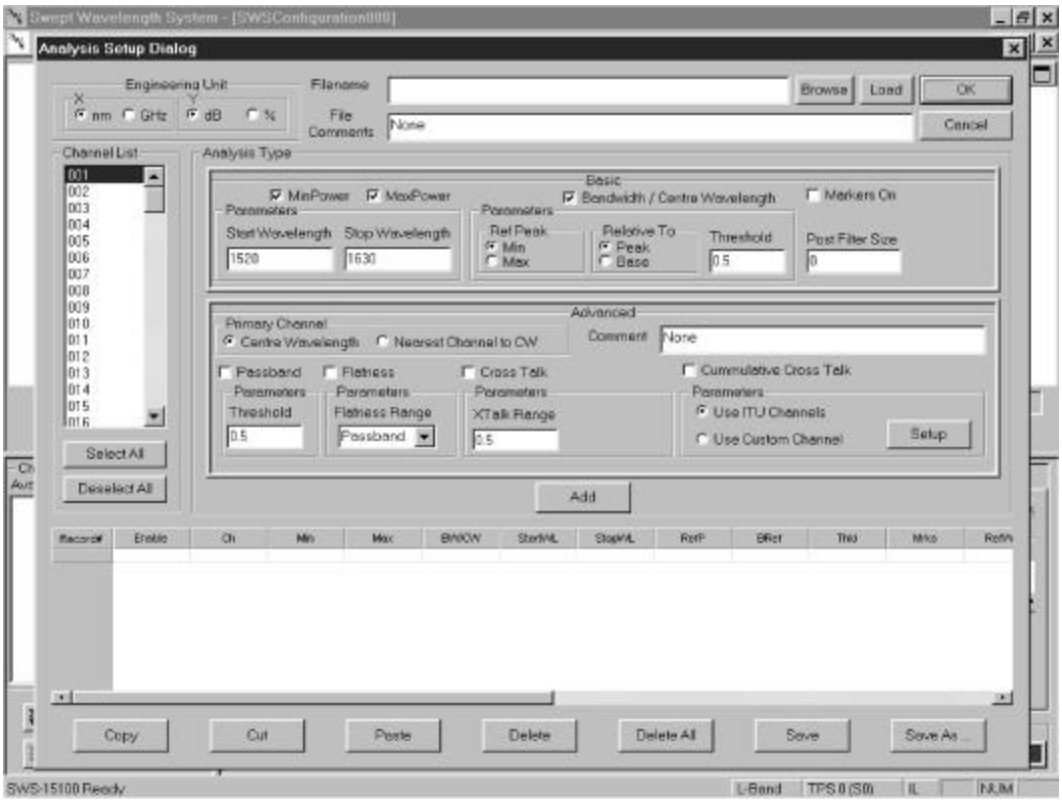

Figure 72: Analysis Setup Dialog Box

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This section of the manual describes how to enter parameters, using the user interface, to conduct analysis. For information on how the SWS program conducts its analysis, see the **How the SWS Calculates Values** section.

Select channels for which analysis is to be performed by highlighting the channel from the list of available channels.

Select the engineering units by using the radio buttons in the top left of the Analysis Setup dialog box.

Define the parameters by entering the appropriate values in the following fields:

- Start Wavelength (mandatory)—This value is the lower bound of the wavelength range over which analysis is conducted. For C-band, the value must be greater than 1520 nm. For L-band, the value must be greater than 1541 nm.

- Stop Wavelength (mandatory)—This value is the upper bound of the wavelength range over which analysis is conducted. For C-band, the value must be less than 1570 nm. For L-band, the value must be less than 1630 nm.

- MinPower and MaxPower (optional, but recommended)—These values are calculated each time by the SWS program, but the user has the option to include these values in the analysis table.

- Bandwidth/Center Wavelength (normally optional, but mandatory for calculating flatness)—When this field is checked, the user must enter parameters to define how the calculations are performed:

    - Ref Peak—Select whether bandwidth and center wavelength are to be measured with respect to maximum peak or minimum peak.

    - Relative To—This section consists of two parameters. In the first parameter, the user selects whether the measure is to be taken with respect to the peak or to the base of the trace. The second parameter, threshold, defines the magnitude measured with respect to the peak or the base, depending on the selection of the first parameter. Threshold is expressed in dB or linear units, ranging between 0 and 1.

See the **How the SWS Calculates Values** section for other examples of measuring bandwidth and center wavelength.

In the advanced section of the Analysis Setup dialog box, the SWS program is set to evaluate the passband, flatness, crosstalk, and cumulative crosstalk characteristics of the channel.

To set the SWS:

1. Define whether the primary channel is determined by making the measurement with respect to the center wavelength or to the nearest channel to the center wavelength. See the **Selecting the ITU Grid or Specifying Channels** section for more information.

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2. Select the checkboxes to turn on the analysis parameters and to fill the required user parameters. The analysis parameters are:

   - Passband—Passband is evaluated at the threshold, which is measured in dB or linear units, from the primary channel. In the Threshold field, enter a value ranging from 0 to 1.

   - Flatness—Flatness is measured across the top of the peak. The bounds of the measured range are defined as either the passband or bandwidth. Alternatively, enter the numerical distance from the primary channel. The distance is in nm or GHz, as defined by the user in the Engineering Unit section of this dialog box. To measure flatness, also define the parameters for passband or bandwidth, as applicable.

   - Crosstalk—Crosstalk is the difference in power between the primary channel and its adjacent channels, which are the channels to the immediate right and left of the primary channel. Adjacent channels are defined by the user in the **Selecting the ITU Grid or Specifying Channels** section.

   - Cumulative Crosstalk—Whereas crosstalk measures the difference in power between the primary channel and the adjacent channels, cumulative crosstalk measures the difference between the power of the primary channel and the sum of the powers of the remaining channels in the defined wavelength range. Adjacent channels are defined by the user in the **Selecting the ITU Grid or Specifying Channels** section.

     For a full description of how SWS defines these values, see the **How the SWS Calculates Values** section.

Selecting the ITU Grid or Specifying Channels

To define new communications channels or to select a standard set of ITU channels, press the Setup button in the Analysis Setup dialog box. A dialog box appears, as shown in Figure 73.

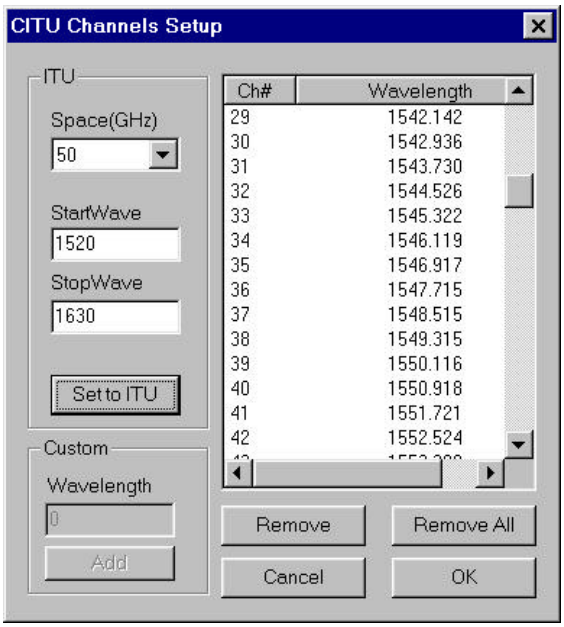

Figure 73: Selection of Channel or ITU Grid Settings

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ITU channels are selected by specifying the channel spacing and the start and stop wavelengths. Custom channel wavelengths can be added by entering the wavelength of the new channel and pressing the Add button. The list of wavelengths defining the channels can be edited by adding or removing channels. To reset to the standard ITU grid, press the Set to ITU button.

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Logging Analysis Results

An additional feature is the ability to log the results of the analysis. To enable logging, check the Log check box. The results of the analysis are logged to the file Analysis.txt in the Analysis subdirectory.

Markers Tab Page

Two markers can be placed on any trace and moved around to obtain the wavelength or frequency difference and the power difference, between any two points, on one or two traces. The markers can be set in absolute wavelength or relative to a reference marker. To select the reference marker, check the Reference Marker check box on the Markers tab page (Figure 74).

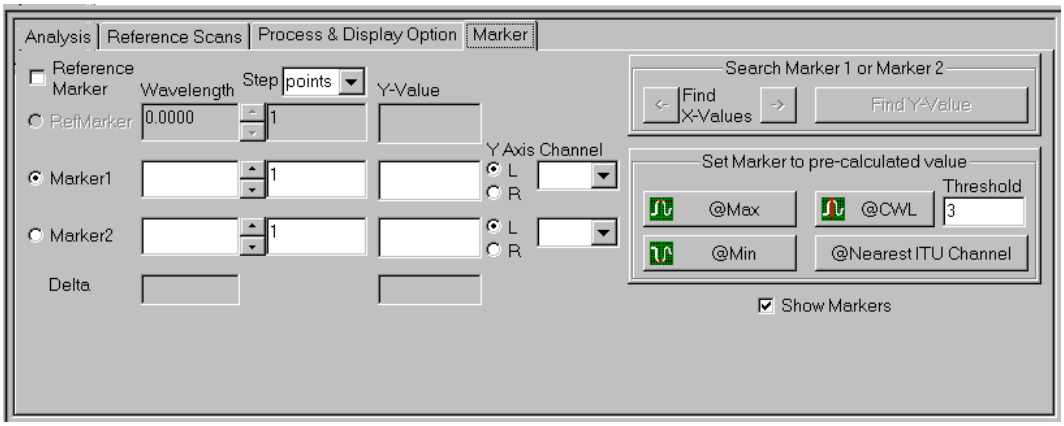

Figure 74: Markers Page

To place the first marker:

1. Select the channel.

2. Select the value for the y-axis, that is, whether the left-hand or right-hand y-axis values are to be used.

3. Select the step size in points or pm for Marker 1.

4. Select the step size in points or pm for Marker 2.

5. Check the box labeled Show Markers.

After the first marker is placed, there are different ways to place other markers.

- Place the marker by clicking at the selected spot. The marker is drawn on the plot and its coordinates in wavelength or frequency and power are displayed in the appropriate boxes.

- Enter the wavelength of the marker position and click the Find Y-Value button; the position of the marker is then computed. The marker is drawn in place and the y-value is entered in its edit field. When both markers have been drawn, the wavelength or frequency difference is computed and displayed in the box labeled Delta. The difference in power is displayed in the box beside it.

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- To place a marker at a peak, select the marker and press the Set @Min or Set @Max button. The selected marker is placed on the appropriate peak. This action provides a simple way, for example, to get the wavelength between two maximum points.

- To set the marker at the center wavelength, press the Set @CWL button, or press the Set @Nearest ITU Channel button. The marker is moved to the nearest ITU channel.

Exiting the Software

The group of configuration windows that are open, along with the properties for each window, is called a workspace. To exit the SWS application, or move to a different test scenario, save the current configuration window setup. For example, save the window settings, layout, and analysis settings. To save the settings, exit the application; the system prompts for file names for each of the configuration windows that are open, plus a filename for the workspace.

Preparing for Measurements

Before DUTs can be tested, the system must be warmed up and zeroed. To warm up the SWS before taking measurements turn on all the power switches of the SWS components and allow the components to warm up for a minimum of two hours, after which it is recommended that the components be left on at all times.

Zeroing the System

Before taking measurements, the system defaults must be set. The default configuration compensates for optical losses in the optical path not caused by the DUT. Zeroing must be done a minimum of once each day. Specifications are written based on a reference made directly before device testing.

To zero the system:

1. Select the physical channel and follow the instructions in the **Using SWS Software** section.

Zeroing for a DUT

To zero the system for a DUT such as a Fiber Bragg Grating, without using a circulator and reflector:

1. Set up the equipment as shown in Figure 75.

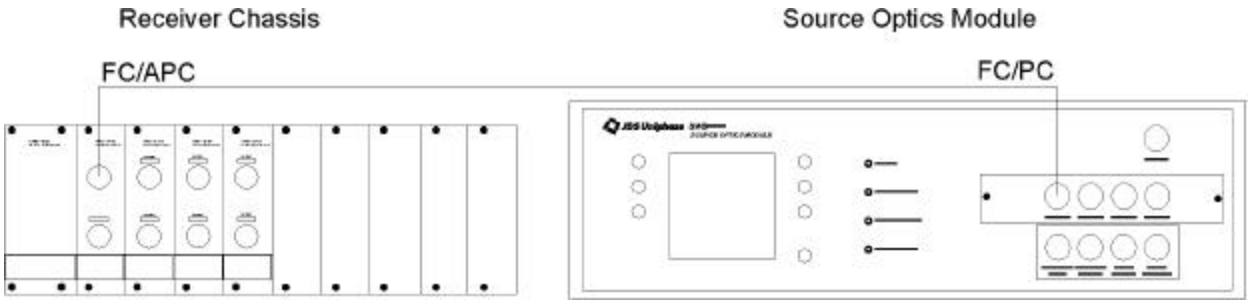

Figure 75: Zeroing the System for a DUT

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2. Select the channels and follow the instructions in the **Using SWS Software** section.

An example of the fiber setup for zero loss is shown in Figure 76, in this case to detector Channel 2. No messages are displayed if there is a problem, such as the wrong detector module channel being used or forgetting to turn the transmitter unit on. The scans are stored by the system.

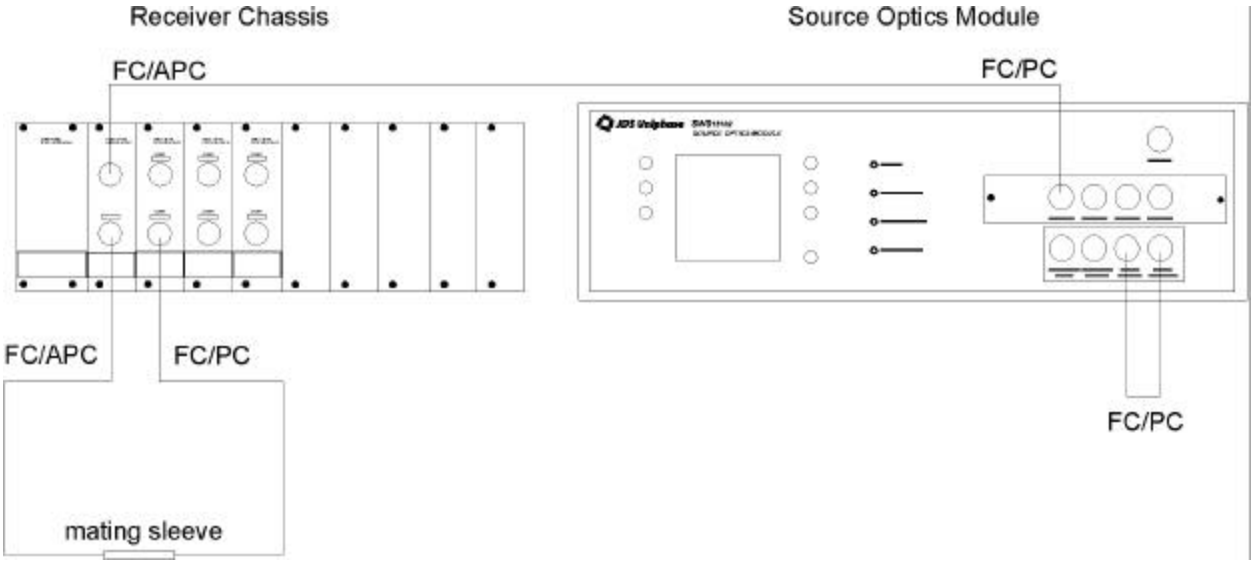

Figure 76: Acquiring a Reference

The next set of reference scans taken overwrites the currently saved scans.

To avoid connector loss variation, do not disconnect the jumper or mating sleeve from the output of the control module after the system has been zeroed.

Example Application: Zeroing for an FBG using a Circulator and Reflector

The system can be zeroed for an FBG using a circulator and a 100% reflector, instead of adding a jumper between the receiver control module and detector module. The JDS Uniphase CR5500 circulator and the JDS Uniphase FR1315 reflector are used for this method. To zero the system for an FBG, using a circulator and reflector:

1. Set up the equipment, as shown in Figure 77. Ensure that the same type of connectors are used for zeroing as are used for testing the DUT, preferably use the same jumpers for both procedures. In Figure 77, the reflector is connected to Port 2, all the light reflected back is sent to Port 3, and Channel 2 is used for the measurement.

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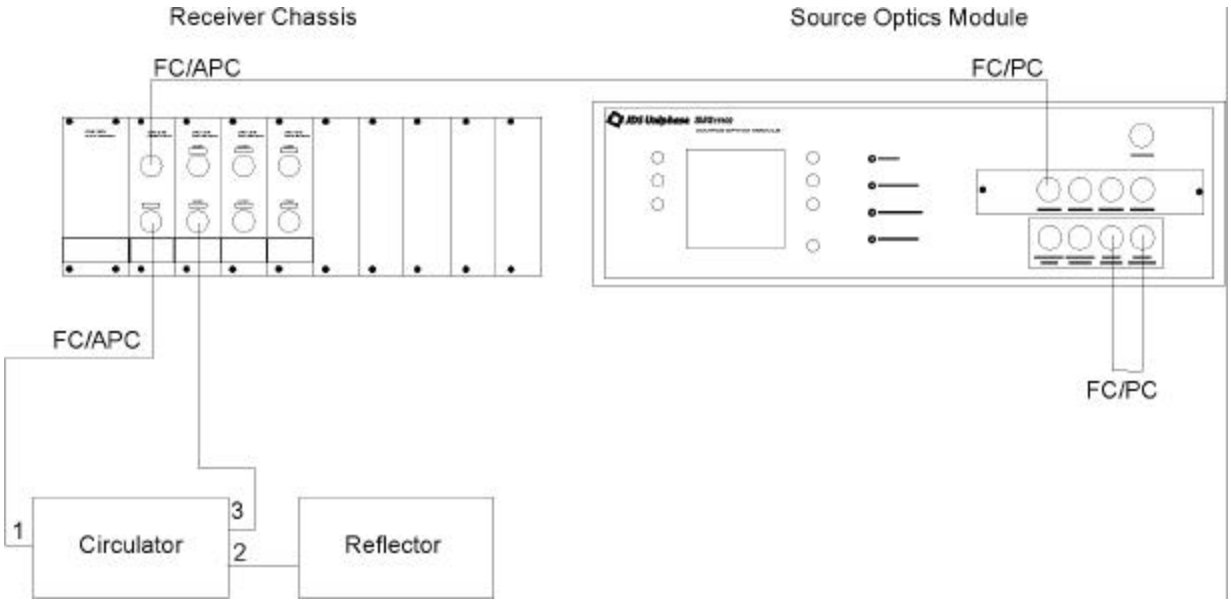

Figure 77: Setup for Zeroing for an FBG

2. Take a reference scan. This scan acquires the zero loss trace for the reflection path. Ensure that the same channels, as were used for characterizing the FBG, are used.

Measuring Dark Voltage

Dark voltage is the residual power left in the system when there is no light going through the system. The detectors generate a small current even when no light falls on them. This feature is caused by current leakage through the detector and is created by background electrical noise, temperature variations, and stray light. The resulting dark voltage can be measured and compensated for during DUT characterization.

It is recommended that a dark voltage measurement be made every time the system is installed in a new location. It establishes the noise floor for all SWS measurements.

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Measuring Zero Loss

Before making measurements, the system characteristics, without a DUT, need to be established. This process is known as zero loss referencing, or simply referencing. Zero loss references must be performed whenever the fibers to the DUT, or from the DUT to the detector module, are changed, moved, or cleaned. If the fibers are left essentially undisturbed, a zero loss reference needs to be done only once a day. The measurement compensates for any optical losses or wavelength dependence not due to the DUT. System specifications are based on a reference made directly before device testing.

To make a good zero loss measurement:

1. Set up the fibers as if to test a device. Instead of connecting the DUT, connect the device input and the channel input using the proper mating sleeve.

A zero loss measurement must be made before any measurement can be made using the SWS. Occasionally, as in the case of measuring a fiber Bragg grating in reflection, the process of zero loss referencing becomes more complicated (see the **Example Application: Characterizing Fiber Bragg Gratings in Reflection** section).

Measuring Insertion Loss

The IL through all channels in a device can be measured quickly and easily as a function of wavelength using the SWS. The wavelength ranges covered in C-band and L-band systems are specified in the **Specifications** section, as are the measurement accuracy, repeatability, and dynamic range.

To measure IL:

1. Set the source optics module to the required polarization state.
2. Select insertion loss mode.
3. Select the channels to process.
4. Perform a zero loss reference scan for each of the selected channels.
5. Connect the device.
6. In the SWS application, select the type of analysis to be performed.
7. Acquire a trace.

The insertion loss trace appears on the screen. To manipulate the screen image, zoom in or out, pan, or select a window on which to zoom in.

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Measuring Polarization Dependent Loss

PDL through a device can be measured using the SWS, using the optional four-state polarization controller (SWS15104). The PDL can be measured for any passive device for insertion losses between 0 and 40 dB. The specifications for PDL measurement are given the **Specifications** section.

PDL measurements in the SWS are made using the Mueller matrix method. The details and theory of measurement are found in the *SWS15104 Four-State Polarization Controller User's Manual* (document SD000327).

Other useful parameters are also calculated with the PDL measurement. The parameters are the minimum IL over all polarization states, the maximum IL over all polarization states, and the average IL. All are available at the same wavelength resolution as IL measurements.

To perform PDL measurements:

1. Set up the device as if for IL measurements and follow the instructions in the **Using SWS Software** section.

2. Set the SOM to polarization mode 1, as explained in the **Setting Source Optics Module Parameters** section.

3. Connect the four-state polarization controller as explained in the *Four-State Polarization Controller User's Manual*.

4. Select PDL in the Mode menu of the software.

5. Select the channels to process.

6. Perform a zero loss reference scan for each of the selected channels.

7. Connect the device.

8. Select the types of traces to be displayed from average IL, minimum IL, maximum IL, and PDL. Select any two types for display at one time. The first display uses the primary y-axis on the left, while the second uses the secondary y-axis on the right.

9. In the SWS application, select the type of analysis.

10. Acquire a trace.

When a PDL measurement is complete, the selected traces are displayed. To change the types of trace displayed without re-acquiring new data, de-select the unwanted traces, select the new ones, and refresh the display.

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Interpreting PDL Data

PDL values calculated by the SWS are obtained from linear combinations of the insertion losses at four polarization states that are well defined, relative to one another. The computation of PDL is accurate to within the level of system noise. At a low IL value, this level is ±0.025 dB, giving an uncertainty in the PDL of 0.05 dB. However, when insertion losses are high, the noise also increases. For example, at 40 dB insertion loss, the noise is ±0.25 dB; therefore, the uncertainty in the PDL measurement increases to ±0.5 dB. Care must be taken when interpreting PDL measurements at high insertion losses.

The effects of system noise on PDL measurements can be reduced in two ways: averaging and smoothing. The number of traces to average can be selected. With averaging over four traces, the noise can be reduced by a factor of two. Smoothing applies a triangular filter to the data. If the half size chosen for smoothing is n, the power at any point is:

$$P(k) = \sum \frac{P(k+r)\,(n+1-|r|)}{(n+1)^2}$$

where P(k) is the power at point k. The sum is for values of r, from -n to +n, for a half filter size of n.

Improvement in device measurement can be achieved by averaging and smoothing the reference in the same way as is done for the traces. As a precaution, do the averaging in PDL mode if a polarization controller is present, even if the measurements are in insertion loss mode.

The effect of smoothing is to reduce the noise over a small wavelength region. Smoothing also has the effect of degrading the wavelength resolution. When smoothing is used, the half-size of the triangular filter must be chosen with the characteristics of the device considered. Care must also be used while interpreting the results. When studying the characteristics of a device in regions where the IL varies rapidly with wavelength, it can be preferable to average over several references and scans to improve the measurement.

Characterizing Specific Devices

Single-Output Devices

Simple passive optical devices that can be characterized using SWS include:

- Attenuators
- Bandpass filters
- Isolators
- Fiber Bragg gratings (in transmission)
- Etalons
- Optical filters

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Acquiring Zero Loss Reference for a Device

For simple passive optical devices, only one channel is required. To characterize a device:

1. Select the processing mode, insertion loss, or PDL. Perform a zero loss measurement for the selected channel, connecting the system, as shown in Figure 78.

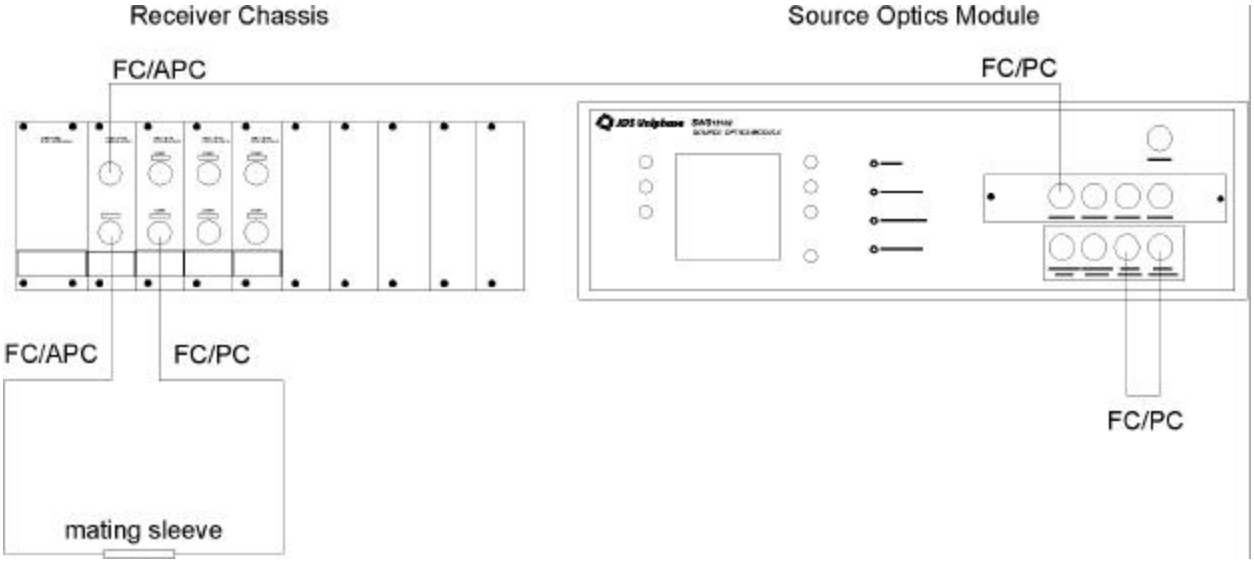

Figure 78: Acquiring a Zero Loss Reference

2. Connect the device using the same jumpers as used for the zero loss reference. Follow the procedure, outlined in the **Measuring Insertion Loss** section for IL measurements or the **Measuring Polarization Dependent Loss** section for PDL measurements, to acquire and display the trace.

Measuring Insertion Loss of a Device

To measure the insertion loss of a device:

1. Connect the DUT to the SWS as shown in Figure 79. Follow the instructions provided in the **Using SWS Software** section to acquire and analyze an insertion loss trace. The section contains an explanation of the types of markers that can be placed on the plot, the various types of analyses that can be performed on the data, and the ways in which the plot can be manipulated.

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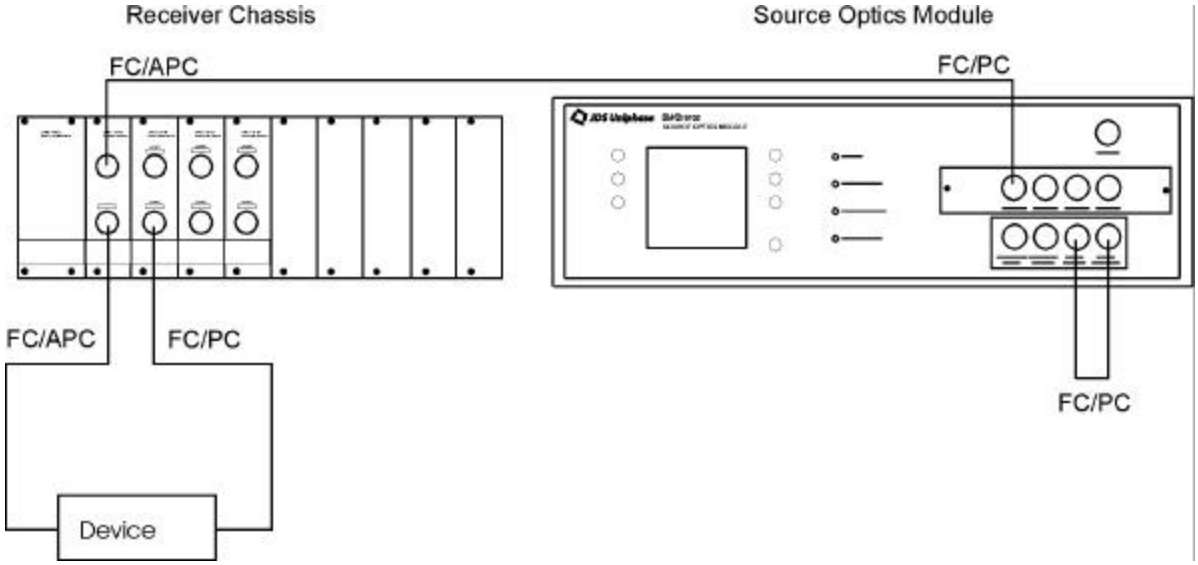

Figure 79: Characterizing a Single-Output Device

Measuring PDL of a Device

The PDL of a device can be measured if the SWS includes the four-state polarization controller (SWS15104). To measure PDL:

1. Perform the zero loss measurement with the software in PDL mode, and the polarization mode set to M1 on the source optics module.

2. Connect the device, as shown in Figure 79, for IL measurement.

3. Select the types of traces to be displayed and the analysis to be performed, as described in the **Using SWS Software** section.

4. Acquire a trace. The selected outputs are displayed in the Chart Area and can be manipulated in the same way as insertion loss plots.

The additional analyses that can be performed, the formats in which the data can be stored, and markers that can be used on these plots are described in the **Using SWS Software** section.

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Multiple-Output Devices

Devices with more than one output can be measured using the SWS in a manner similar to measuring simple passive optical devices. To measure multiple-output devices:

1. **Acquire zero loss reference**—Zero loss references need to be acquired for each of the selected channels, in the selected processing mode (IL or PDL). To acquire the required zero loss references, proceed as for a single-output device, but repeat the process for each of the output channels.

2. **Measure insertion loss**—To measure the insertion loss of a multiple-output device, connect the device into the SWS as shown in Figure 80. The output of the control module is connected to the common or input port of the device. A separate detector channel is used for each of the outputs from the device. The measurement of all the channels is done simultaneously.

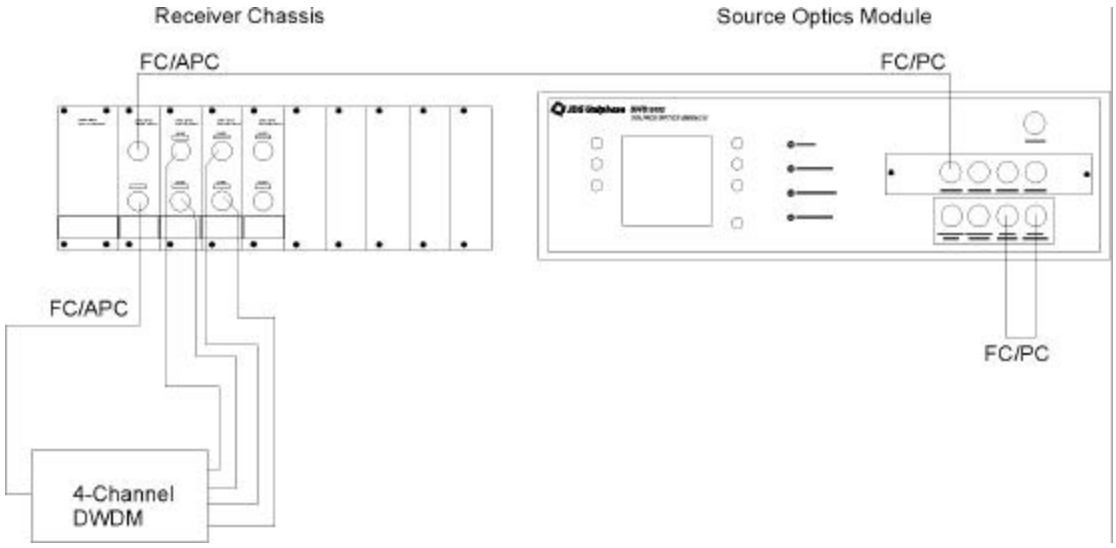

Figure 80: Characterizing a Multiple-Output Device

3. Use the software to select the channels to be processed and acquire a trace. The results for all selected channels are displayed in the chart area. These plots can be analyzed and manipulated. For more information, see the **Using SWS Software** section.

4. **Measure PDL**—Characterizing a multiple-output device for PDL is very similar to acquiring the IL trace, the differences being that the software must be in the PDL mode and the SOM must be set in Polarization Mode 1. All selected output channels are measured simultaneously. Interpreting PDL results is somewhat more complex than IL. See the **Interpreting PDL Data** section for more information.

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Example Application: Characterizing Fiber Bragg Gratings in Reflection

Fiber Bragg Gratings work by reflecting the light back into the wavelength region that they are designed to filter out. When measuring the gratings in transmission considerable light is reflected back into the Control Module. The Control Module is designed to accommodate this phenomenon.
A circulator is needed for this measurement. In addition, a 100% reflector is required for the reference. It is not recommended that the device be measured in both transmission and reflection simultaneously. Also, special care needs to be taken that the transmitted portion of the light is prevented from corrupting the measurement in reflection. As in any SWS measurement, the first step is to acquire the zero loss reference. Next, the device is connected and the measurement is performed.

Measuring Insertion Loss of an FBG

To measure the insertion loss of the FBG in reflection:

1. Connect the FBG to the system, as shown in Figure 81.

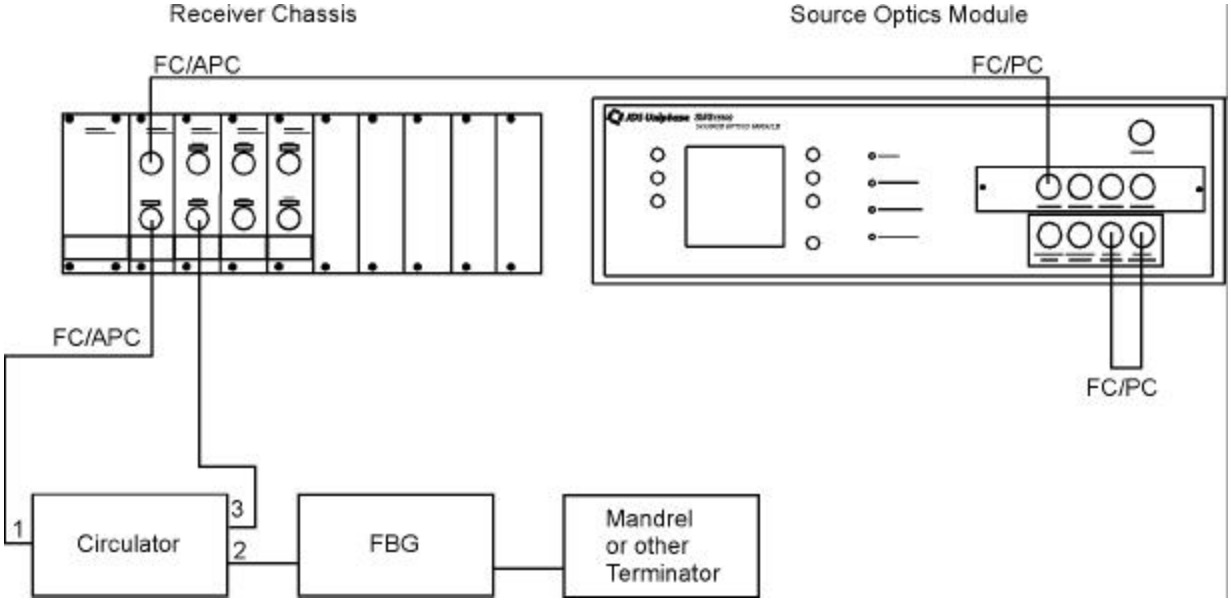

Figure 81: Setup for Characterizing the FBG

2. To perform the reflection measurement, replace the reflector with the FBG and terminate the transmitted output of the FBG using a mandrel termination or similar technique. The mandrel termination is used to prevent possible reflection of light to Port 2 back through the grating and the corruption of the insertion loss measurement by the reflected light. Corruption can reduce the insertion loss by as much as 10 dB. The reflection measurement is made on Channel 2 of the receiver, which is consistent with the way the zero loss measurements are performed.

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Measuring PDL of an FBG

The PDL characteristics of an FBG can be measured using the same setup for zero loss measurement and data acquisition as for insertion loss. The difference is that the software must be set in the PDL mode and the SOM in Polarization Mode 1. For more information, see the **Using SWS Software** section.

Calibrating the Equipment

General Information

There are two parameters for which the SWS is calibrated: power and wavelength.

Power calibration is performed at the factory. It is performed for both the control and detector modules. To satisfy ISO 9000 requirements, each detector module must be re-calibrated at least once a year for power. The user can perform the calibration or the module can be returned to the factory for calibration. The procedure for power calibration of the detector modules is described in the **Calibrating Power** section. If the power calibration is suspect, it can be verified using the procedure described in the **Verifying Power Calibration** section.

Wavelength calibration is performed at the factory when a complete system is shipped. However, the user must perform wavelength calibration on a receiver or control module when it is shipped as a separate unit, or if a control module or receiver is moved from one transmitter to another, or if an addition wavelength range is added. Re-calibration for Power is not required when an additional wavelength range is added. It is recommended that wavelength calibration be verified once each week when the system is in constant use and each time the system is used when it is used infrequently.

Calibrating Wavelength in the Swept Wavelength System

When do I Confirm Wavelength Accuracy? When do I Calibrate?

The SWS15100 and SWS16100 instruments are designed to operate with a wavelength accuracy of ±3 pm. To verify System calibration, connect a gas reference cell (such as that within the SOM) as you would at DUT and make a measurement. Compare measured absorbtion line wavelengths with the tables given later in this section.

To Calibrate the Wavelength Scale:

Wavelength calibration is a relatively simple procedure that takes little time, the procedure consists of 7 simple steps: Before proceeding, ensure that all equipment is fully warmed up, ie switched on for at least two hours.

- Ensure the tunable laser source is properly calibrated.
- Connect the acetylene gas cell to your receiver.
- Enter the Calibration Dialog Box in the SWS version 3.0.2 software.
- Acquire a trace of the gas cell, with its pronounced absorption peaks.

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- Calibrate the SWS to the acetylene trace.
- Save the calibration values to the EEPROM in the Control Module in the receiver.
- As an added option, choose whether to restore previously saved calibration values into the EEPROM from the INI file.

Ensure the tunable laser source is properly calibrated.

For standard laser operation during recalibration, refer to the laser manual for operating instructions.

1. Ensure that the tunable laser source is properly calibrated. A calibrated wavelength meter is required for this operation. Start by connecting the output of the laser to the wavelength meter (Figure 82).

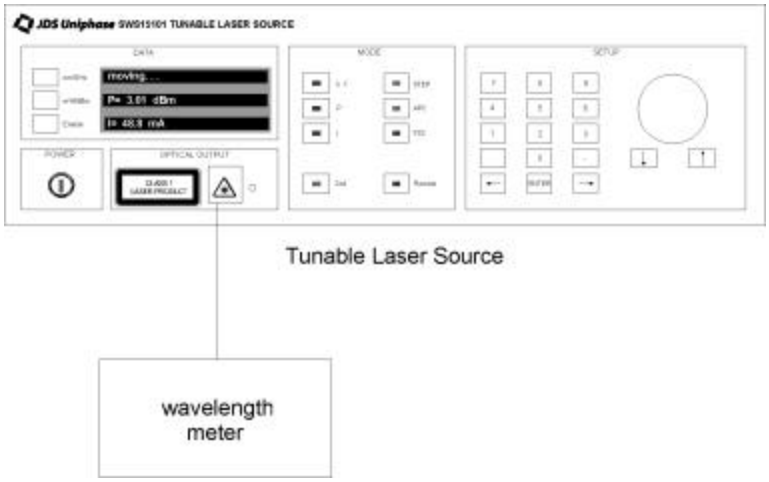

Figure 82. Tunable Laser Source Calibration Setup

2. Set the wavelength of the tunable laser source to 1520 nm for a C-band system or 1540 nm for an L-band system. Compare the setting with the meter reading.

3. Set the wavelength of the tunable laser source to 1570 nm for a C-band system or 1630 nm for an L-band system. Compare the setting with the meter reading.

4. If the difference for either reading is more that 0.2 nm, recalibrate the tunable laser source. Start by pressing the 2nd key, followed by the λ key. The display automatically shows a short wavelength in the tuning range. There is a prompt to enter the measured wavelength; therefore, reading from the meter, enter the measured wavelength on the tunable laser source using the numbered keys and then press the Enter key. The short wavelength is set.

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5. A long wavelength is automatically displayed in the tuning range. There is a prompt to enter the measured wavelength; therefore, reading from the meter, enter the measured wavelength on the tunable laser source using the numbered keys and then press the Enter key. The long wavelength is set. Check the calibration by setting the tunable laser source to arbitrary wavelengths and checking the wavelength using the meter. Ensure the differences between values are less than 0.2 nm.

6. Disconnect the wavelength meter from the tunable laser source. Reconnect the laser input to the Laser In connector on the source optics module.

Connect the Acetylene Gas Cell to your Receiver.

The acetylene cell is built into the SOM, and can be accessed through the front panel. Alternatively, you may also use an external gas cell, which could make it easier for you to do calibrations, if the SWS receiver is not located close to the transmitter. Connect the cell as you would a DUT

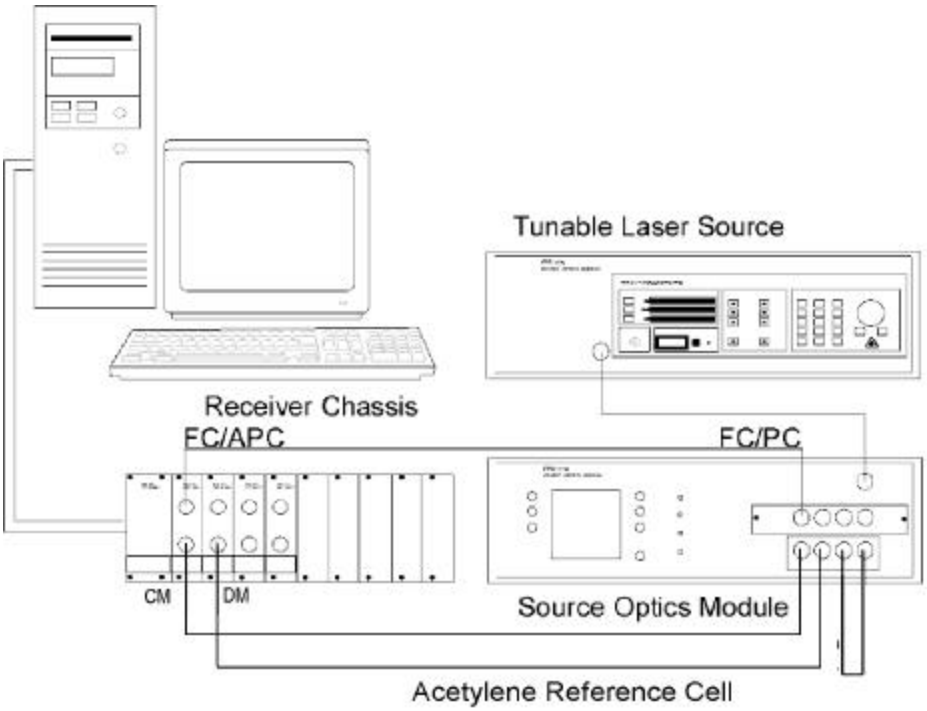

Figure 83. Set up the system in this way to calibrate receiver.

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Select the Band from the menubar of the SWS software.

Select either the C- or L-band from the menu bar. You can not choose to do C and L bands simultaneously. The default settings require the use of Acetylene 12 gas cell (as fitted within the C Band SOM) for C Band calibration, and the Acetylene 13 cell such as that within the L Band SOM for L Band calibration. See end of this section to make changes to these defaults when calibrating with a different gas cell (eg., Acetylene 13 for C-Band).

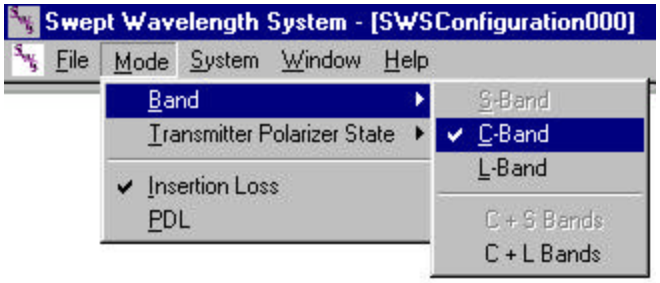

Figure 84. Select the Calibration option from the menubar

Enter the Calibration Dialog Box in the SWS software.

Along the menu bar of the main window of the software, select `System>Calibration`.

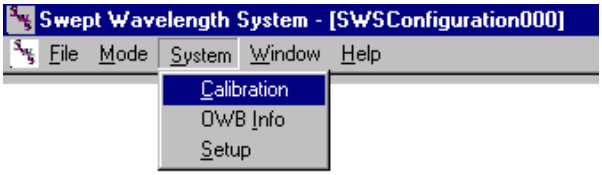

Figure 85. Select the Calibration option from the menubar

A window with tabs appears. Select the Wavelength Calibration tab to see the following dialog box.

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Acquire a trace of the gas cell, with its pronounced absorption peaks.

1. Under the Channel Setup section of the Wavelength Calibration Window, select the channel that the gas cell is connected to. Ensure that a reference has been done for this channel.

2. Press the `Start Acquisition` button to acquire the trace of the gas cell.

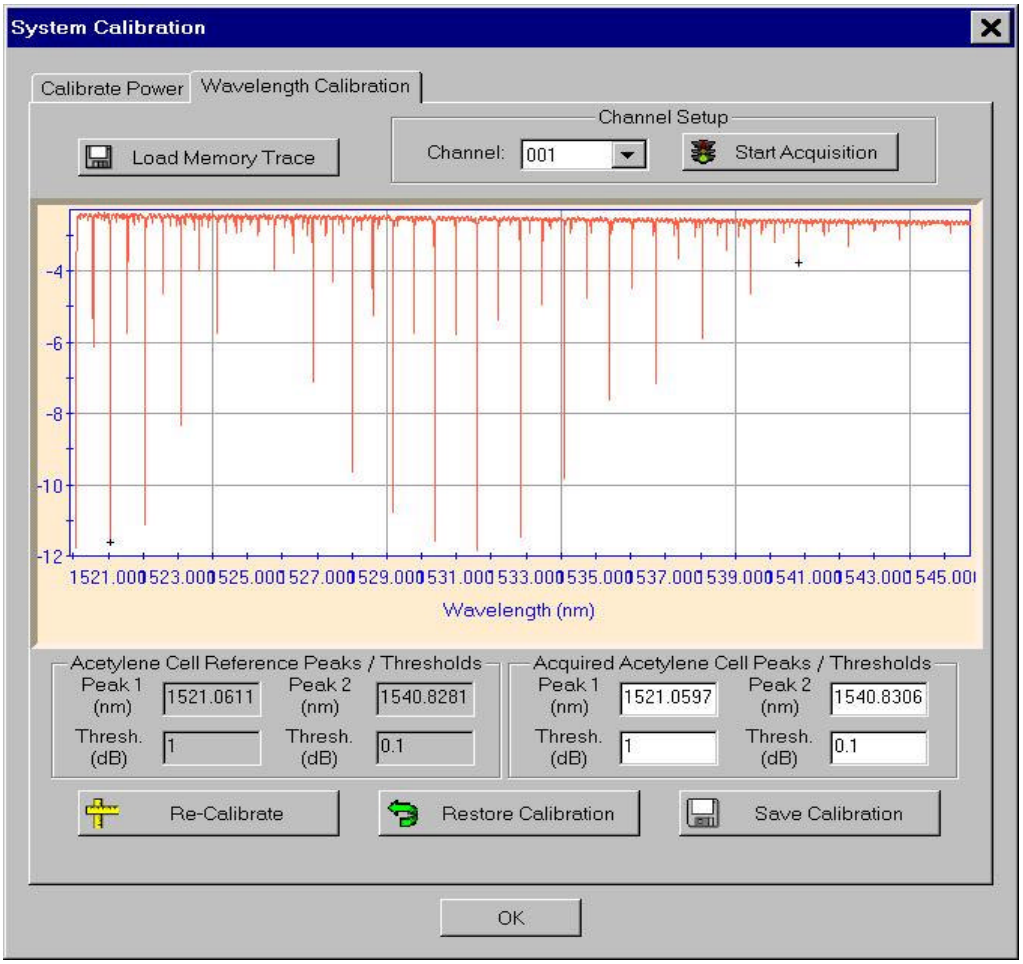

Figure 86. C Band Trace using 12C2H2 Acetylene Cell

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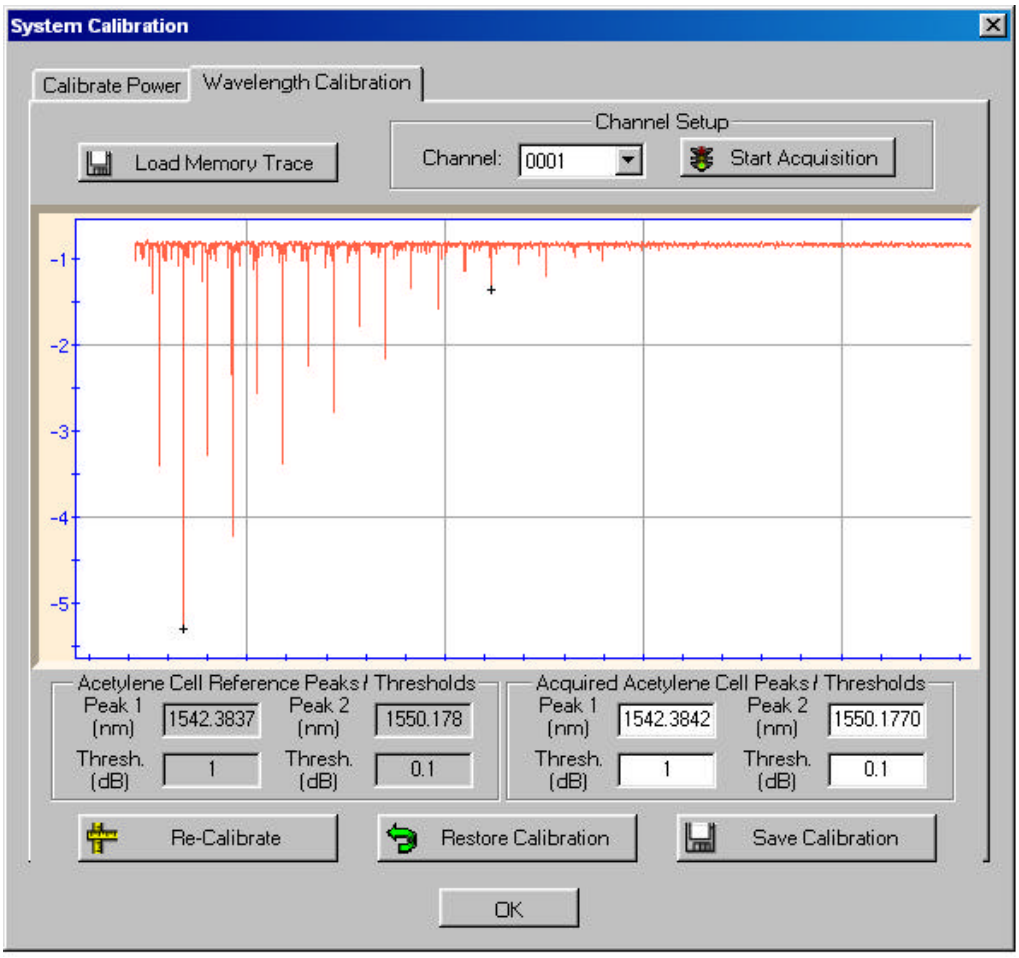

Figure 87. L Band Trace using 13C2H2 Acetylene Cell

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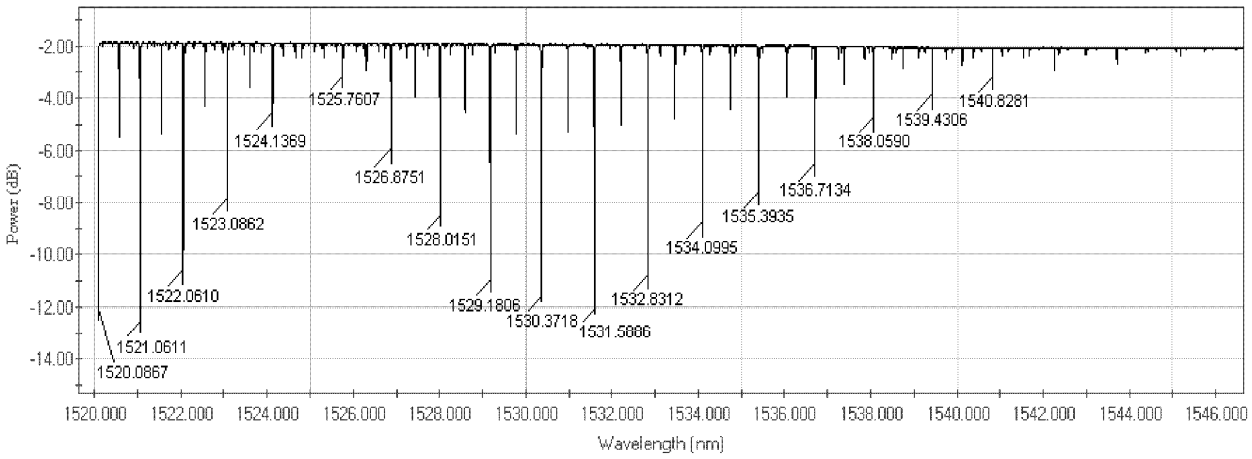

Figure 88: Absorption Lines of $^{12}C_2H_2$ Acetylene Cell

Table 14: Wavelengths of Absorption Lines for $^{12}C_2H_2$ Acetylene Cell

Peak	Peak Wavelength (nm)	Wavelength Reading (nm)	Difference within ±0.003 nm?	Peak	Peak Wavelength (nm)	Wavelength Reading (nm)	Difference within ±0.003 nm?
R 25	1513.2007			P 1	1525.7607		
24	1513.5839			2	1526.3147		
23	1513.9733			3	1526.8751		
22	1514.3690			4	1527.4419		
21	1514.7710			5	1528.0151		
20	1515.1793			6	1528.5946		
19	1515.5939			7	1529.1806		
18	1516.0148			8	1529.7730		
17	1516.4419			9	1530.3718		

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Peak	Peak Wavelength (nm)	Wavelength Reading (nm)	Difference within ±0.003 nm?	Peak	Peak Wavelength (nm)	Wavelength Reading (nm)	Difference within ±0.003 nm?
16	1516.8754			10	1530.9770		
15	1517.3152			11	1531.5886		
14	1517.7613			12	1532.2067		
13	1518.2138			13	1532.8312		
12	1518.6725			14	1533.4621		
11	1519.1376			15	1534.0995		
10	1519.6090			16	1534.7433		
9	1520.0867			17	1535.3935		
8	1520.5707			18	1536.0502		
7	1521.0611			19	1536.7134		
6	1521.5579			20	1537.3830		
5	1522.0610			21	1538.0590		
4	1522.5704			22	1538.7416		
3	1523.0862			23	1539.4306		
2	1523.6084			24	1540.1261		
1	1524.1369			25	1540.8281		

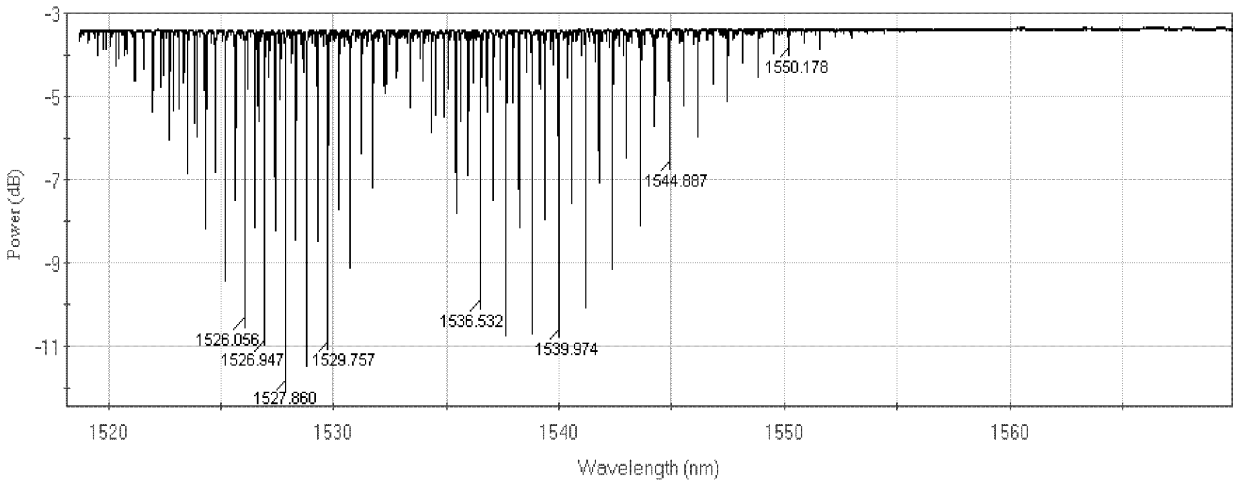

Figure 89: Absorption Lines of $^{13}C_2H_2$ Acetylene Cell

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Table 15: Wavelengths of Absorption Lines for $^{13}C_2H_2$ Acetylene Cell

Peak	Peak Wavelength (nm)	Wavelength Reading (nm)	Difference within ±0.003 nm?	Peak	Peak Wavelength (nm)	Wavelength Reading (nm)	Difference within ±0.003 nm?
R 24				P 1	1533.8180		
23	1522.3320			2	1534.3499		
22	1522.7226			3	1534.8872		
21	1523.1191			4	1535.4298		
20	1523.5213			5	1535.9779		
19	1523.9293			6	1536.5316		
18	1524.3431			7	1537.0909		
17	1524.7626			8	1537.6559		
16	1525.1880			9	1538.2267		
15	1525.6190			10	1538.8032		
14	1526.0558			11	1539.3855		
13	1526.4984			12	1539.9735		
12	1526.9467			13	1540.5674		
11	1527.4007			14	1541.1670		
10	1527.8604			15	1541.7724		
9	1528.3259			16	1542.3837		
8	1528.7972			17	1543.0008		
7	1529.2740			18	1543.6237		
6	1529.7566			19	1544.2525		
5	1530.2449			20	1544.8872		
4	1530.7389			21	1545.5278		
3	1531.2385			22	1546.1742		
2	1531.7436			23	1546.8266		
1	1532.2541			24	1547.4849		
0	1532.7701			25	1548.1491		
				26	1548.8193		
				27	1549.4954		

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Peak	Peak Wavelength (nm)	Wavelength Reading (nm)	Difference within ±0.003 nm?	Peak	Peak Wavelength (nm)	Wavelength Reading (nm)	Difference within ±0.003 nm?
				28	1550.1776		

Calibrate the SWS to the acetylene trace.

1. The objective of calibrating the SWS is to get a best-fit match between the gas cell reference values and the acquired trace values.

2. On the plot, double click at The first peak position to be recalibrated. The wavelength will then be shown in the Peak 1 field in the Acquired Acetylene Cell Peaks area of the window. Double click at a second peak position to be recalibrated. The second wavelength will then be shown in the Peak 2 field.

3. Click the Re-Calibrate button. The user is asked to continue or advised that the calibration is complete. Click the Yes button to continue, the software acquires another trace. Double-click on the two peaks as in the previous step and press recalibrate. Calibration is now complete, click OK.

4. If step 3 is necessary for more than 5 iterations, a system error is indicated, please contact JDS Uniphase customer support.

Save the calibration values to the Eeprom in the Control Module in the receiver

To save the calibration values to the EEPROM in the receiver, click on the `Save Calibration` button. A dialog box will appear asking if you want to save the previously stored values in the eeprom to the INI file. Say yes to this option if you plan on reverting to the old values in the future.

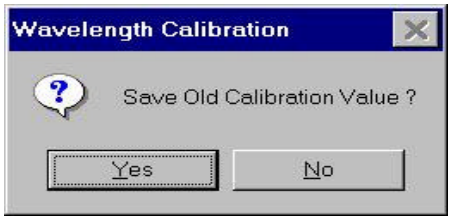

Figure 90

To revert to the old calibration, click the Restore Calibration button. The following dialog box will appear.

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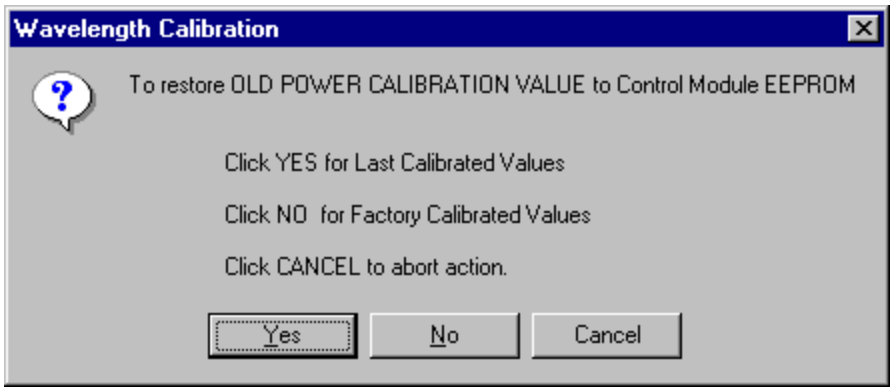
Wavelength Calibration
To restore OLD POWER CALIBRATION VALUE to Control Module EEPROM
Click YES for Last Calibrated Values
Click NO for Factory Calibrated Values
Click CANCEL to abort action.
Yes
No
Cancel

Figure 91. Click "YES" to restore the last calibration data

Note. Latest calibration data currently stored in the EEPROM is lost and the old calibration data is restored.

If there is more than one receiver chassis hooked up to your transmitter, use the instructions above to calibrate one receiver chassis, and then copy the calibration constants to the Control Modules in the other receivers. This saves you time.

Calibrating Multiple Receivers

Up to four receiver stations can be connected to each transmitter station. To copy the calibration constants from the first receiver to other receivers:

1. Perform the wavelength calibration on one receiver. Save the new calibration data, but do not save the old calibration.

2. Save the calibration data again by selecting as if to save the old calibration data. This procedure saves the current calibration data in the SWS15100.INI file in the C:\WINDOWS directory.

3. Copy the SWS15100.INI file to a diskette.

4. At each additional receiver station, edit the SWS15100.INI file, using a text editor such as Notepad, by copying the old calibration data from the diskette to the file. Save the new SWS15100.INI file as text.

5. Run the SWS program.

6. From the main window of the software, select the System menu, choose the Calibration option, and select the Wavelength Calibration tab. The Wavelength Calibration window appears.

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7. Do not perform the calibration. Click the Restore Calibration button. Select Yes to restore the last calibration values. The calibration data is copied from the .INI file to the control module of the receiver.

8. Repeat the procedure for each receiver station. When the procedures are complete, all receivers connected to the same transmitter have identical wavelength calibration.

9. Repeat the procedure on all receivers if the source optics module or the tunable laser source is changed.

Using Alternative Gas Cells

As an alternative to the gas cell built into the SOM other gas cells can be used. The table below shows recommended alternative gas cells for calibration of C and L Band receivers

.

Wavelength Range	Gas Cell	Refer to this Table and Graph	Notes
C-Band	Carbon 13 $^{13}C_2H_2$	Table 15: Wavelengths of Absorption Lines for ^{13C2H2} Acetylene Cell Figure 86. C Band Trace using ^{12C2H2} Acetylene Cell	This is the cell fitted within the L-Band SOM.
L-Band	Hydrogen Cyanide $H^{13}C^{14}N$	Table 16: Wavelengths of Absorption Lines for H13C14N Cell Figure 93: Absorption Lines of H13C14N Cell	This gas cell is available in an external configuration. Due to shipping restrictions, may not be available in all areas.
C-Band	Hydrogen Cyanide $H^{13}C^{14}N$	Table 16: Wavelengths of Absorption Lines for H13C14N Cell Figure 93: Absorption Lines of H13C14N Cell	This gas cell is available in an external configuration. Due to shipping restrictions, may not be available in all areas.

In order to set up the system for calibration with alternative gas cells, the SWS15100.ini file must be modified. The .ini file view below shows how the calibration parameters are grouped as C – Band and L- Band. The C – Band Calibration Parameters, for example are shown for Carbon 12, Carbon 13 and HCN, all but the Carbon 12 are “commented” out by the use of (;) at the

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beginning of the line. The effect of this is that the Carbon 12 parameters are used for C – Band calibration. To calibrate using an alternative cell, remove the (;) from the 4 lines relating to that cell and add them before the lines for the Carbon 12 section. Save these changes and restart the SWS15100 program to perform calibration with your new choice of gas cell.

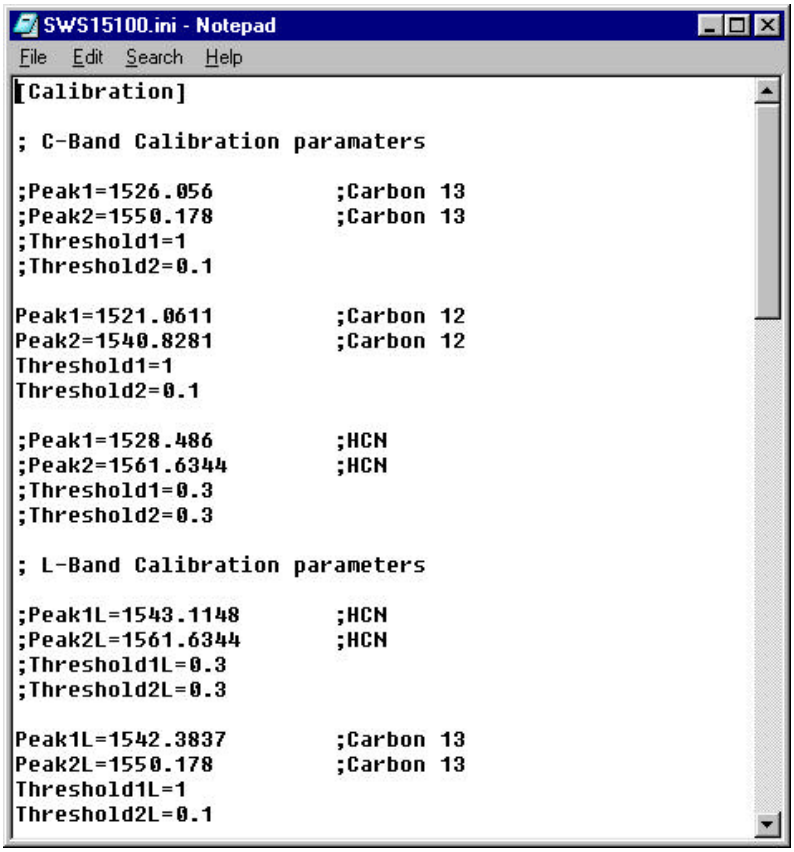

Figure 92. View of the INI file in Microsoft Notepad.

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L-Band or C-Band Calibration Using the $H^{13}C^{14}N$ Cell

The following figure shows the absorption lines when using an $H^{13}C^{14}N$ hydrogen cyanide cell for calibration.

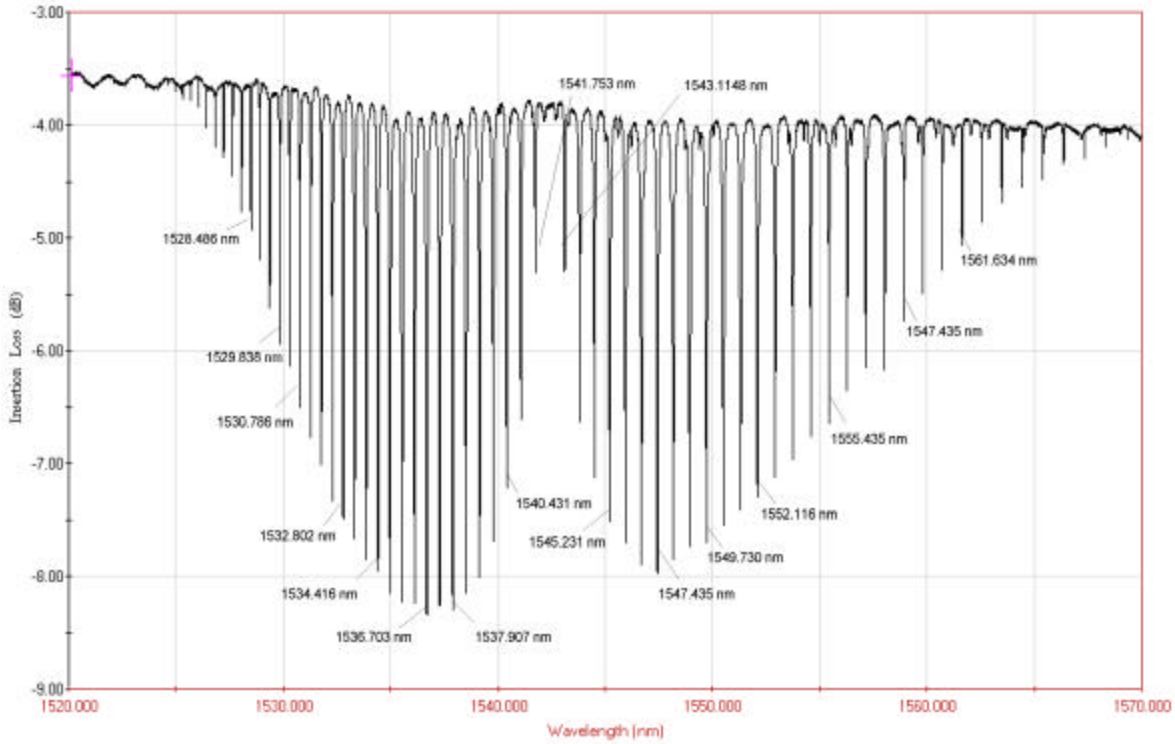

Figure 93: Absorption Lines of $H^{13}C^{14}N$ Cell

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Use the following table to record the wavelengths of the absorption lines when using the $H^{13}C^{14}N$ acetylene cell for calibration.

Table 16: Wavelengths of Absorption Lines for $H^{13}C^{14}N$ Cell

Peak	Center Wavelength (nm)	Wavelength Reading (nm)	Difference within ±0.003 nm?	Peak	Center Wavelength (nm)	Wavelength Reading (nm)	Difference within ±0.003 nm?
R 25	1528.054			P 1	1543.1148		
24	1528.486			2	1543.809		
23	1528.927			3	1544.515		
22	1529.376			4	1545.231		
21	1529.838			5	1545.956		
20	1530.306			6	1546.690		
19	1530.786			7	1547.435		
18	1531.276			8	1548.190		
17	1531.774			9	1548.955		
16	1532.283			10	1549.730		
15	1532.802			11	1550.515		
14	1533.329			12	1551.311		
13	1533.867			13	1552.116		
12	1534.416			14	1552.931		
11	1534.972			15	1553.756		
10	1535.540			16	1554.589		
9	1536.117			17	1555.435		
8	1536.703			18	1556.292		
7	1537.300			19	1557.157		
6	1537.907			20	1558.033		
5	1538.522			21	1558.919		
4	1539.149			22	1559.814		
3	1539.786			23	1560.719		
2	1540.431			24	1561.634		
1	1541.087			25	1562.563		
0	1541.753						

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Verifying Power Calibration

The insertion losses of two detector channels, under identical measurement conditions and using the same device, are normally identical. If the insertion losses are not the same, power calibration of the suspect channel must be verified.

The following equipment is required for verifying and calibrating power:

- Second laser source (does not need to be tunable)
- NIST traceable power meter with monitor output
- JDS Uniphase HA9 Series Extended Range Programmable Optical Attenuator, with two outputs
- Wavelength meter (optional)

To verify power calibration:

1. Set up the equipment as shown in the following figure. The example shown uses Channel 2 of the receiver. The polarization controller is not used when verifying power calibration.

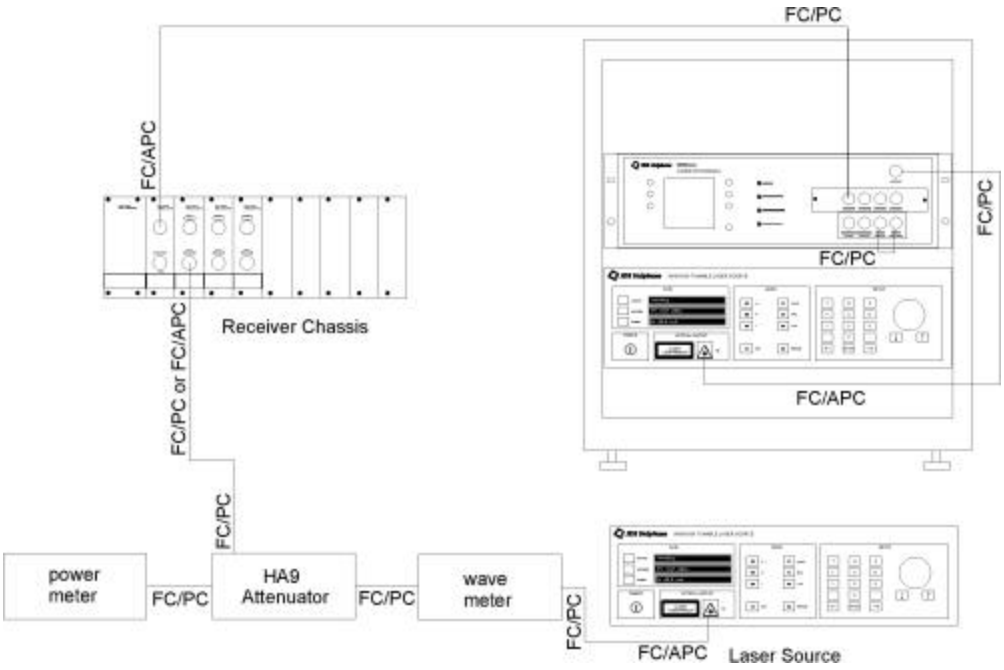

Figure 94: Power Calibration Setup

2. Use the wave meter to set the wavelength of the second laser source to 1550 nm.

3. Set the power on the second laser source to 0 dBm.

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4. Set the HA9 attenuator to 0 dB attenuation.

5. Using the power meter, measure the power going to the channel being tested.

6. Using the SWS software, set the system to insertion loss mode and polarization mode 0. Perform a zero loss measurement.

7. Increase the attenuation on the HA9 attenuator by 5 dB.

8. Using the SWS software, acquire a scan.

9. Double-click the left mouse button at 1550 nm to measure the insertion loss.

10. Record the HA9 attenuation and the measured insertion loss.

11. Repeat Steps 7 through Step 10, until the attenuation reaches 65 dB.

12. From the measured insertion losses, compute the error at each attenuation level.

13. Verify that the measured errors fall within the limits specified for all attenuation levels. See the SWS optical specifications in the **Specifications** section (Table 5).

14. If the errors are larger than specified, perform power calibration on the channel.

Calibrating Power

Calibrate the power scale for each receiver detector channel once a year or more often if the power measurements are suspect. This procedure takes approximately 10 minutes for each channel. Calibration requires the same equipment and setup as for verification.

To calibrate the power:

1. Using the software, select the System menu, choose the Calibration option, and the Power Calibration tab. The Power Calibration window appears (Figure 95).

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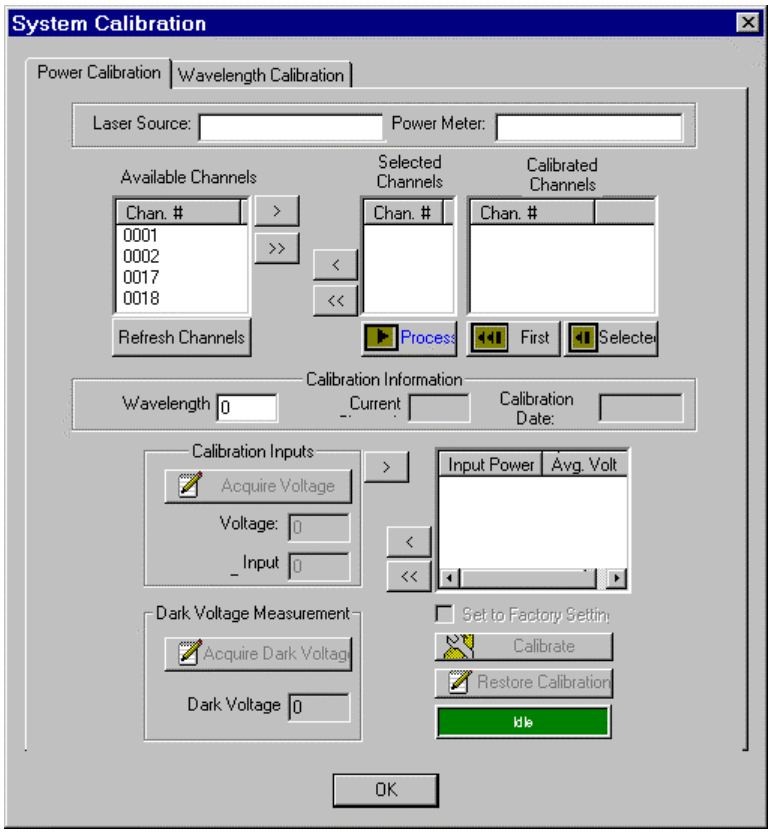

Figure 95: Power Calibration Window

2. Type the names of the equipment being used for calibration in the Laser Source and Power Meter fields.

3. If necessary, click the Refresh Channels button to redisplay the channels in the Available Channels column.

4. Select the Available Channels to be calibrated.

5. Click the > or >> button to load the channels. The channels appear in the Selected Channels column.

6. Set up the equipment as for power verification, previously shown in Figure 94. The example shown uses Channel 2 of the receiver.

7. Turn on the second laser source. Ensure the laser power is between 0 and -10 dBm. A laser wavelength setting of 1550 nm is recommended. Use of a wavelength meter to monitor laser wavelength is optional.

8. Set the two-output channel HA9 attenuator so that the laser power to the detector module is between 0 and -40 dBm. This power is monitored using the power meter.

9. Use the software to click the Process button to initiate the calibration process. The current channel is shown in the Current Channel field, with the Calibration Date.

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10. Type the second laser source wavelength in the Wavelength field (for example, 1550 nm).

11. Click the Acquire Voltage button. The average voltage of the selected channel is measured and the voltage is displayed in the Voltage field.

12. Type the input power shown on the power meter in the Input Power field.

13. Click the > button beside the Acquire Voltage button. The results are shown in the Input Power and Avg. Volt columns.

14. Increase the level of attenuation on the attenuator by 5 dB, click the Acquire Voltage button, type in the Input Power, and click the > button.

15. Repeat Steps 11 to 14 until enough voltages for a linear plot (a minimum of four values is recommended) have been acquired by increasing the attenuation, clicking the Acquire Voltage button, inputting the Input Power, and clicking the > button. The Acquire Dark Voltage button becomes active during the process.

16. Delete any Input Power and Avg. Volt reading by clicking the left arrow button beside the Input Power column.

17. Click the Acquire Dark Voltage button. Dark voltage is the residual power left in the system when there is no light going through the system. A message is displayed asking the user to cap the detector or terminate the fiber. To do this, for example, on the HA9 attenuator, press the ∞ key. Alternately, put the cap on the detector module on the receiver. The dark voltage is displayed in the Dark Voltage field.

18. Click the Calibrate button. There is a prompt to save old data to the computer before writing over the data or write over the data without saving the old data. The calibration information is saved.

19. Repeat the process for each channel. Calibrated channels appear in the Calibrated Channels list. Click the First button to redo all measurements or the Selected button to redo measurements for selected channels only. Activate the HA9 attenuator again by pressing the ∞ key.

20. When the testing is finished, disconnect the HA9 attenuator, wave meter, and power meter.

Restoring Factory Calibration Values

Factory power and wavelength settings can be restored using the SWS software. Reset is done, for example, when the user has difficulty performing a wavelength calibration because the lines are difficult to identify, or if the internal acetylene cell is too far from the receiver and no external acetylene or HCN cell is available to do the wavelength calibration. Factory power calibration can be restored if the equipment required to do power calibration is not available, and the unit was calibrated at the factory less than a year earlier.

To restore the factory power calibration:

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1. From the Power Calibration window (Figure 95), select one channel from the Selected Channels list, click the Process button, and select the Set to Factory Settings option. The factory settings are reset.

2. Repeat the process for the next channel.

To restore the factory wavelength calibration:

1. In the SWS program, select Insertion Loss mode.

2. From the System menu, select Calibration.

3. Select the Wavelength Calibration tab in the dialog box that appears.

4. Click the Restore Calibration button at the bottom of the dialog box.

5. In the message box that appears, click the No button to select Factory Calibrated Values.

If there are unexpected results, contact JDS Uniphase.

Enabling Wavelength Diagnostics on C-Band and L-Band SWS Systems

In systems used in applications where it is necessary to monitor wavelength accuracy, or where wavelength instability is suspected, a wavelength diagnostic feature can be enabled. When the feature is enabled, the wavelength accuracy is tested after every scan and errors are logged to a file. The user is informed immediately of any wavelength instability.

To enable wavelength diagnostics on both C- and L-band systems:

1. Edit the SWS15100.INI file.

2. Reset the number of points on the SOM.

3. Perform wavelength calibration.

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Changing the .INI File on C-Band Systems

If the SWS15100 application is running, terminate it. Open the SWS15100.INI file. It is located in the C:\Windows directory in Windows 95/98 or the C:\Win32 directory in Windows NT. Edit the SWS15100.INI file to make the following changes and additions:

1. In the [DATA] section, change the value of MaxPoints to 18500.

2. Add a [GENERAL] section with the following lines:

   ```
   [GENERAL]
   Diagnostics=1
   DiagnosticsLog=1
   LambdaMax=1570
   ```

3. Add a [Band Info] section, with the following lines:

   ```
   [Band Info]
   C-Start=1520
   C-Stop=1570
   ```

4. Save the file.

Changing the .INI File on L-Band Systems

If the SWS15100 application is running, terminate it. Open the SWS15100.INI file. It is located in the C:\Windows directory in Windows 95/98 or the C:\Win32 directory in Windows NT. Edit the SWS15100.INI file to make the following changes and additions:

1. In the [DATA] section, change the value of MaxPoints to 29700.

2. Add a [GENERAL] section with the following lines:

   ```
   [GENERAL]
   Diagnostics=1
   DiagnosticsLog=1
   LambdaMax=1630
   ```

3. Add a [Band Info] section, with the following lines:

   ```
   [Band Info]
   L-Start=1540
   L-Stop=1630
   ```

4. Save the file.

Resetting the Number of Points on the Source Optics Module

Parameters in the SOM can be changed using the RS232 Control port. The following items are required for resetting parameters on the SOM:

- RS232 cable extension cable, with a DB-9M connector at one end and a DB-9F at the other (depending on the COMM port on the computer)

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- A terminal program, such as Hyperterminal, which is supplied with Windows 95, or Terminal, supplied with DOS.

In the following procedure, Hyperterminal is used. The procedure for setting the number of points on the SOM is:

1. Connect the computer Comm Port 1 to the RS232 Control port on the SOM. The SOM has several RS232 ports (each is clearly labeled). Ensure that the correct port is selected.

2. Run the Hyperterminal program.

3. Create a new connection.

4. In the Hyperterminal program, select the File and Properties menu items. Set the communications protocol to the following values:

Bits per second	1200
Data bits	8
Stop bits	1
Parity	None
Flow Control	None

5. Select ASCII Setup from SETTINGS. Select the following options:

   Send line ends with line feeds
   Echo typed characters locally
   Append line feeds to incoming line ends
   Wrap text

6. Type ***IDN? <CR>** A line starting with "JDS Uniphase" is displayed. If the system does not respond to keyboard inputs, check the REMOTE LED on the front panel of the SOM. The LED should be lit. If it is not lit, communication between the computer and the SOM has not been established. Check the connections and try again. If communication cannot be established, or if communication is established but the SOM does not respond to keyboard inputs, try the other COMM port on the computer. If communication cannot be established, call the JDS Uniphase service hotline.

If communication between the SOM and the computer is established, perform the following procedure to enter the parameter to be initialized in the SOM, where <CR> denotes carriage return:

1. Enter the following line:

   :FCOUNT?<CR> (Correct response from the SOM is a value of 17500 for a C-band SOM

2. Enter the following lines:

   :FCOUNT 18500<CR> (C-band) or :FCOUNT 29700<CR> (L-band)
   :SAV<CR>
   :FCOUNT?<CR>

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3. Wait for the system to respond with a value of 18500 (C-band) or 29700 (L-band).

This sequence of commands enters the parameter required to configure the SOM for wavelength diagnostics.

Verify that the parameter “Points” has been entered into the SOM correctly. To verify this, press the DISPLAY button on the SOM, when it has stopped (not scanning). The correct value of Points is 18500 for C-band and 29700 for L-band.

Calibrating Wavelength for Diagnostics

When the SWS software is run, the program prompts the user to perform wavelength calibration. Wavelength diagnostics cannot be used until the calibration has been performed. See the Error! Reference source not found. section for more information on calibration.

Using Wavelength Diagnostics

When a trace is obtained, a wavelength check is performed. If the wavelength is shifted by more than 3 pm, the user is warned that there is a drift. The message “Wavelength measurement

If the wavelength is shifted by more than 30 pm, the user is prompted to perform a wavelength calibration. The message “Laser out of calibration” is generated.

Maintaining the System

The Swept Wavelength System does not require user maintenance. See the **Cleaning Connectors** section for maintenance of connectors.

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Application Development using the SWS DLLs

The Swept Wavelength System is delivered with a set of Dynamic Link Libraries (DLLs) that can be used to develop software to suit unique measurement requirements. The DLLs access the SWS receiver hardware, thereby allowing access to all SWS functionality. Using the supplied DLLs, applications can be developed in the following environments:

- Microsoft Visual Basic (VB)
- C or C++
- Pascal
- National Instruments LabVIEW

The DLLs provide all the hardware control capability, such as trace triggering, data acquisition, and front panel LED control, that are required to build applications to suit research, production, or test environments. These DLLs can be used to perform all the basic processing of raw data.

This section explains the development of user-specific applications using the DLLs. In addition to the DLL information provided in this document, examples using SWS DLLs are provided in the distribution CD-ROM and can be accessed from the SWS15100\Development\examples directory after software installation.

DLL Architecture

The SWS15100.DLL software is built as a Win32 C subroutine library on top of a set of three DLLs that control and manage all system hardware and its basic functions (Table 17). These DLLs are OWB1.DLL, OWB2.DLL, and OWB3.DLL.

Table 17: DLL Architecture

Level	Structure
6 (highest)	Client Applications (written in Visual Basic[1], C, LabVIEW[2], and others)
5	SWS15100.DLL (located in the Development directory)
4	OWB3.DLL (located in the SWS15100 directory)
3	OWB2.DLL (located in the SWS15100 directory)
2	OWB1.DLL (located in the SWS15100 directory)
1 (lowest)	Hardware

Installing the Dynamic Link Libraries

The SWS DLLs are delivered as part of the basic SWS software distribution. You will find the DLLs you need to start building your own applications in the directory where you installed the SWS15100 application.

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Using the DLL Components

The development environment includes the header files and a VB module for the SWS DLL. From these files, it is possible to develop definition files for other WIN32 environments (for example, Delphi and Borland C++). Included with the system is a library file for Microsoft Visual C++.

Development Environment

The SWS DLL can be used in any WIN32 environment that supports access to external DLL library files. Examples are provided on the SWS CD-ROM, in the Development directory for Visual Basic 4.0 and Visual C++ (console application).

The SWS DLL system is currently supported only in a single thread environment and is not guaranteed to be thread-safe. The SWS DLLs are written to support multiple, single-thread applications that do not compete for the SWS hardware. Multiple windows are allowed because they do not execute simultaneously. The SWS DLLs do not support multiple threads in a single process.

When developing applications using the DLLs, it can be necessary to copy the DLLs to some other directory, depending on the development platform. The resident directories for different platforms, where the DLLs must be installed, are shown in Table 18. [Installed Directory] refers to the root directory, where SWS15100.EXE resides. The default is \Program Files\JDS Uniphase\SWS15100. [WinSysDir] is the system directory. In Windows 95/98, it is \Windows\System and in Windows NT, it is \WinNT\System32. [WinDir] is the Windows directory. In Windows 95/98, it is \Windows and for Windows NT, it is \WinNT.

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Table 18: Files used by SWS Software

File Name	Directory	Application	Comments
SWS15100.DLL	[Installed Directory] \Development	C++	Move to the directory where the development application resides
		LabVIEW	Move to the LabVIEW default directory
		VB	Move to [WinSysDir]
OWBSYS.DLL	[WinSysDir]	C++	Leave in [WinSysDir]
		LabVIEW	Leave in [WinSysDir]
		VB	Leave in [WinSysDir]
OWB1.DLL	[Installed Directory]	C++	Move to the directory where the development application resides
		LabVIEW	Move to the LabVIEW default directory
		VB	Move to [WinSysDir]
OWB2.DLL	[Installed Directory]	C++	Move to the directory where the development application resides
		LabVIEW	Move to the LabVIEW default directory
		VB	Move to [WinSysDir]
OWB3.DLL	[Installed Directory]	C++	Move to the directory where the development application resides
		LabVIEW	Move to the LabVIEW default directory
		VB	Move to [WinSysDir]

When testing or running applications that are developed using the DLLs, a number of binary files are created in subdirectories. Do not delete any of these files or directories. To allow the DLL functions to access all the correct files, specify the path to the root directory when calling the function initSWS.

Precautions:

- Allocate an array of exactly 128 short integers (16-bit) for the channel list
- Allocate enough memory for the wavelength and insertion loss data arrays

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DLL Function Descriptions

The functions contained in the DLLs are listed in the following sections. For each function, the calling sequence and parameters are provided for both C and Visual Basic (VB). In addition, a short description of the function's purpose is provided.

Initializing and Referencing the SWS

The following functions are used to initialize and reference the SWS.
Note that a separate getPDLReference function is used to get zero loss references in PDL mode. That function is documented under the section PDL Functions.

Function Name	Description
initSWS	Initializes the DLL sub-system
getDarkVoltage	Collects the dark voltage trace from the hardware
IsDarkVoltage Done	Checks if a dark voltage measurement has been performed for the specified channel.
GetAverageDark VoltagePower	Finds average power measured during a dark voltage measurement.
isZeroLossDone	Checks if a zero loss reference has been done for a specified polarization
getReference	Collects the zero loss reference trace data from the hardware. Call this function after triggering a trace with the triggerTrace function.
getAverageZeroLoss Power	Gets the average zero loss power for a specified channel and polarization

Insertion Loss Functions

The following functions are used to acquire Insertion Loss traces from the SWS. Follow the programming flowcharts in the Programming Guide to tie these functions together.

Function Name	Description
getTraceStatus	Gets the hardware trace status.
triggerTrace	Triggers a new trace
isTraceDone	Determines whether the trace has been completed
getTraces	Collects the trace data from the hardware
getDataSize	Determines the length of the trace from the start wavelength to the maximum wavelength, defined by LambdaMax in the SWS15100.INI file
getILTrace	Returns the IL trace from the last collection

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Polarization Dependent Loss Functions

The following functions are used to acquire PDL traces from the SWS.
It is not necessary to triggerTrace before calling getPDLreferences, as in the case of using getReference for IL Zero Loss Reference.
Follow the programming flowcharts in the Programming Guide to tie these functions together.

Function Name	Description
getPDLReferences	Gets all four zero loss references for all four polarization states S1, S2, S3, and S4 required for a PDL measurement
acquirePDL	Acquires all insertion loss data required for a PDL measurement
processPDL	Processes the four insertion loss traces acquired through a call to the function acquirePDL to compute PDL
getPDLTrace	Gets all four PDL traces for a specific channel, after all acquired channel traces have been computed by the processPDL function
getTracePolarization	Determines the polarization state of the last trace collected
setPolarizationControl	Sets the polarization flag that enables or disables polarization change
getPolarizationControl	Gets the status of the polarization flag
getChannelPolarization	Retrieves the polarization of the trace for the specified channel in cache memory.

Choosing between C and L Band

Use this function to toggle between C and L Bands when using a Dual Band Selector Switch Module (DBSSM).

Function Name	Description
setBand	Sets the wavelength band (C or L) to be processed next

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Analytical Functions

Use these functions to conduct analysis on your acquired data.

Function Name	Description
getPeakPower	Returns the peak power for a given trace
getBandwidth	Returns the bandwidth for a given trace
getCenterWave	Returns the center wavelength for a given trace
getLocalPeakPower	Finds the peak power in a specified wavelength range
getLocalBandwidth	Finds the bandwidth of the largest peak, in a specified wavelength range
getLocalCenterWave	Finds the center wavelength of the largest peak, in a specified wavelength range
getPassBand	Computes the passband over the entire scan
getLocalPassBand	Computes the passband in a specified wavelength range
getFlatness	Computes the flatness of a trace within specified wavelengths
getITUSize	Computes the number of ITU channels
getITU	Calculates the ITU channel wavelengths and frequencies
getCrossTalk	Returns power levels required for computing the crosstalk

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Miscellaneous Functions

These functions can be used to enhance your custom application.

Function Name	Description
getChannelList	Gets the channel list for the SWS hardware connected
getOWBInfo	Gets the information for each of the modules in the channel list
writeLED	Writes a character string to the LEDs of a given channel
blinkLED	Controls the blinking of the LEDs for a given channel
setUnits	Sets the working units for the X-axis to either nm or GHz
getUnits	Gets the current units for the X-axis

Finishing Your SWS Session

Use this function call to close down your SWS program when you have finished using it.

Function Name	Description
terminateSWS	Terminates SWS processing, cleans up memory, and closes files.

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Interface Descriptions

initSWS

Function	Description
Purpose	The initSWS function initializes the SWS DLL sub-system. This function must be called before any other function is called.
C prototype	int initSWS(unsigned short baseAddress, unsigned short nominalSize, char *Path);
VB prototype	Declare Function initSWS Lib "SWS15100" (ByVal baseAddress%, ByVal nominalSize%, ByVal Path$) As Long
Input	**unsigned short baseAddress**: This is the ISA base address of the OWB interface card. This address is determined at system installation. The default baseAddress is hexadecimal 240. **unsigned short nominalSize**: This is the nominal number of points in a complete scan. **char *Path**: This is the path specifying the root directory.
Output	No output.
Return Value	When there is no error, the function returns 1. When there is an error, the return value contains the error number. The error numbers are defined in the file SWS15100.h, which is on the SWS CD-ROM.

triggerTrace

Function	Description
Purpose	The triggerTrace function is used to trigger a new trace. Before this function is called, call getTraceStatus to ensure that no data is being collected.
C prototype	int triggerTrace( );
VB prototype	Declare Function triggerTrace Lib "SWS15100" () As Long
Input	None
Output	None
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

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getTraceStatus

Function	Description
Purpose	The getTraceStatus function is used to return the status of the trace.
C prototype	int getTraceStatus( );
VB prototype	Declare Function getTraceStatus Lib "SWS15100" () As Long
Input	None
Output	None
Return Value	When there is no error, the function returns the status. The status is bit encoded as follows: Bit 1(LSB): Card busy = 1, Card Idle=0 Bit 2 : Card Overflow=1, Card Normal =0 Bit 3 : A/D Active= 1, A/D Idle =0 Bit 4 to15 : Undefined When there is an error, the return value contains the negative error number.

getChannelPolarization

Function	Description
Purpose	The getChannelPolarization function retrieves the polarization of the trace for the specified channel in cache memory. Note: This function returns the last polarization for specified channel, the last time any data was collected for the channel. To find the latest polarization, use getTracePolarization instead.
C prototype	int getChannelPolarization(unsigned short chID, short *polar);
VB prototype	Declare Function getChannelPolarization Lib "SWS15100" (ByVal ChID%, ByRef polar%) As Long
Input	**Unsigned short chID:** Channel ID for which polarization is sought.
Output	**short *polar**: This is a set of integers defined as: { S0 = 0, S1 = 1, S2 = 2, S3 = 3, S4 = 4, POLARIZATION_END_MARKER = 5 }.
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

isDarkVoltageDone

Function	Description
Purpose	The isDarkVoltageDone function is used to check if a dark voltage

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Function	Description
	measurement has been performed for the specified channel.
C prototype	int isDarkvolatgeDone(unsigned short chID, char *timeStamp)
VB prototype	Declare Function isDarkVoltageDone Lib "SWS15100" (ByVal chID%, ByVal timeStamp$) As Long
Input	**unsigned short chID**: This is the channel to be checked.
Output	**char *timeStamp**: This is the time of the last zero loss reference for the specified polarization. At least 32 characters must be assigned to this array.
Return Value	When a dark voltage measurement has been done for the specified channel, the return value is 1 (TRUE). When a dark voltage measurement has been done for the specified channel, the return value is 0 (FALSE). When there is an error, the return value contains the error number.

getAverageDarkVoltagePower

Function	Description
Purpose	The getAverageDarkVoltagePower function is used to get the average power measured during a dark voltage measurement. This function is called after the dark voltage measurement for the specified channel has been performed.
C prototype	int getAverageDarkVoltagePower(unsigned short chID, double *dAvePower)
VB prototype	Declare Function getAverageDarkVoltagePower Lib "SWS15100" (ByVal chID%, ByRef dAvePower As Double) As Long
Input	**unsigned short chID**: This is the channel number.
Output	**double *dAvePower**: This is the average dark voltage power in dBm.
Return Value	If there is no error, the return value is 0. If there is an error, the return value contains the error number.

isTraceDone

Function	Description
Purpose	The isTraceDone function checks for the status of data acquisition.

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Function	Description
C prototype	int isTraceDone( );
VB prototype	Declare Function isTraceDone Lib "SWS15100" () As Long
Input	None
Output	None
Return Value	When the trace is done, the function returns 1. When the trace is not done, the function returns 0. When there is an error, the return value contains the error number (< 0).

getTraces

Function	Description
Purpose	The getTraces function stores the raw data, to cache, acquired through a call to the triggerTrace function.
C prototype	int getTraces(unsigned short *channelList, unsigned short numChannels);
VB prototype	Declare Function getTraces Lib "SWS15100" (ByRef channelList%, ByVal numChannels%) As Long
Input	*channelList is a pointer to the channel list; numChannels is the number of channels from which data is to be collected.
Output	None
Return Value	When there is no error, the function returns the number of bytes written to cache. When there is an error, the return value contains the error number.

getTracePolarization

Function	Description
Purpose	The getTracePolarization function retrieves the polarization of the acquired trace collected with the getTraces function.
C prototype	int getTracePolarization(short *polar);
VB prototype	Declare Function getTracePolarization Lib "SWS15100" (ByRef polar%) As Long
Input	None
Output	**short *polar**: This is a set of integers defined as: { S0 = 0, S1 = 1, S2 = 2, S3 = 3, S4 = 4, POLARIZATION_END_MARKER = 5 }.

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Function	Description
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

getDataSize

Function	Description
Purpose	The getDataSize function retrieves the number of data points in the trace from the start wavelength to the maximum wavelength defined by LambdaMax in the SWS15100.INI file.
C prototype	int getDataSize( );
VB prototype	Declare Function getDataSize Lib "SWS15100" () As Long
Input	None
Output	None
Return Value	When there is no error, the function returns the length of the data array or the number of data points from the start wavelength to the maximum wavelength. When there is an error, the return value contains the error number (is negative).

getReference

Function	Description
Purpose	The getReference function acquires a new reference for the specified channel. The polarization of the new reference is stored in the variable pola. This function is called after the user acquires raw data through a call to the triggerTrace and isTraceDone functions, with the setup for channel reference measurement in place.
C prototype	int getReference(unsigned short chID, short *pola);
VB prototype	Declare Function getReference Lib "SWS15100" (ByVal chID%, ByRef pola%) As Long
Input	**unsigned short chID**: This is the channel ID to be referenced. **short *pola**: Variable pola contains the polarization of the new reference.
Output	None
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

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getDarkVoltage

Function	Description
Purpose	The getDarkVoltage function acquires a new dark voltage value for the specified channel. This function is called after the user acquires raw data through a call to triggerTrace and isTraceDone functions with the setup for a dark voltage measurement in place (for example, detector capped).
C prototype	int getDarkVoltage(unsigned short chID);
VB prototype	Declare Function getDarkVoltage Lib "SWS15100" (ByVal chID%) As Long
Input	**unsigned short chID**: This is the channel ID for which the dark voltage measurement is updated.
Output	None
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

getILTrace

Function	Description
Purpose	The getILTrace function calculates the IL of a DUT that is connected to the specified channel chID. The user must allocate space for pLamData and pPowData arrays that become filled with IL trace points.
C prototype	int getILTrace(unsigned short chID, double *pLamData, double *pPowData, unsigned short dataSize, short *pola);
VB prototype	Declare Function getILTrace Lib "SWS15100" (ByVal chID%, ByRef pLamData As Double, ByRef pPowData As Double, ByVal dataSize As Long, ByRef pola%) As Long
Input	**unsigned short chID**: This is the channel ID for which the IL trace is required. **unsigned short dataSize**: dataSize is the size of arrays pLamData and pPowData allocated by the user. This is the size of the acquired trace retrieved by the user using the function getDataSize.

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Function	Description
Output	**double *pLamData**: The pLamData array stores wavelength for each data point in the trace. The function updates the array and the pointer to the array is passed as input. **double *pPowData**: The pPowData array stores the IL power level (dB scale). Each value from pPowData array has a corresponding wavelength value in the pLamData array. The function updates the array and the pointer to the array must be passed as input. **short *pola**: The function returns the polarization of the current processed trace.
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

getPeakPower

Function	Description
Purpose	The getPeakPower function retrieves the power of the largest peak that is contained in the pPowData power array. Call the function after obtaining pPowData data through a call to the getILTrace function. The refpeak parameter must be filled by the caller.
C prototype	int getPeakPower(double *pLamData, double *pPowData, unsigned short dataSize, unsigned short refpeak, unsigned short *peakIndex, double *pPowPeak, double *pLamPeak);
VB prototype	Declare Function getPeakPower Lib "SWS15100" (ByRef pLamData As Double, ByRef pPowData As Double, ByVal dataSize%, ByVal refPeak%, ByRef PeakIndex%, ByRef pPowPeak As Double, ByRef pLamPeak As Double) As Long
Input	**double *pLamData**: The pLamData array stores the wavelength for each data point in the trace. **double *pPowData**: The pPowData array stores the measured power levels (dB scale) for each point in the trace. Each point from the pPowData array has a corresponding point in the pLamData array. **unsigned short dataSize**: This is the size of arrays pLamData and pPowData allocated by the user. This is the size of the acquired trace retrieved by the user using the function getDataSize. **unsigned short refpeak**: This is an integer set of values:

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Function	Description
	{MAX_PEAK_REF = 0(find maximum peaks), MIN_PEAK_REF = 1(find minimum peaks)}
Output	**unsigned short *peakIndex**: This is the position of the peak in the pPowData array. **double *pPowPeak**: This is the power of the peak, the maximum power of the pPowData array. **double *pLamPeak**: This is the wavelength of the peak that corresponds to the pPowPeak value.
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

getBandwidth

Function	Description
Purpose	The getBandwidth function calculates the bandwidth of the largest peak that is contained in the pPowData power array. Call this function only after obtaining the pPowData array through a call to the getILTrace function. The characteristics of the peak as refpeak, interLevel, and baseref must be filled by the caller.
C prototype	int getBandwidth(double *pLamData, double *pPowData, unsigned short dataSize, unsigned short refpeak, double interLevel, unsigned short baseRef, double *pBandwidth);
VB prototype	Declare Function getBandwidth Lib "SWS15100" (ByRef pLamData As Double, ByRef pPowData As Double, ByVal dataSize%, ByVal refPeak%, ByVal InterLevel As Double, ByVal baseRef%, ByRef pBandwidth As Double) As Long
Input	**double *pLamData**: The pLamData array stores the wavelength for each data point in the trace. **double *pPowData**: The pPowData array stores the measured power levels (dB scale) for each point in the trace. Each point from the pPowData array has a corresponding point in the pLamData array. **unsigned short dataSize**: This is the size of arrays pLamData and pPowData, allocated by the user, and is the size of the acquired trace returned by the function getDataSize. **unsigned short refpeak**: This is an integer type that has the following set of values: {MAX_PEAK_REF = 0, MIN_PEAK_REF = 1} **double interLevel**: The interpolation level is the height from the peak where the bandwidth is

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Function	Description
	calculated. **unsigned short baseRef**: This is Boolean. For minimum peaks, the baseRef is 1 and the bandwidth of the peak is calculated from the base of the peak. For maximum peaks, the baseRef is 0 and the bandwidth is calculated from the peak.
Output	**double *pBandwidth**: The pBandwidth stores the bandwidth of the peak.
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

getCenterWave

Function	Description
Purpose	The getCenterWave function calculates the center wavelength and its corresponding power for the largest peak that is contained in the pPowData array. This function must be called only after the user has obtained pPowData and pLamData arrays through a call to the getILTrace function. The parameters refpeak and interLevel are supplied by the caller.
C prototype	int getCenterWave(double *pLamData, double *pPowData, unsigned short dataSize, unsigned short refpeak, double interLevel, unsigned short baseRef, double *pCenLam, double *pCenPow);
VB prototype	Declare Function getCenterWave Lib "SWS15100" (ByRef pLamData As Double, ByRef pPowData As Double, ByVal dataSize%, ByVal refPeak%, ByVal InterLevel As Double, ByVal baseRef%, ByRef pCenLam As Double, ByRef pCenPow As Double) As Long
Input	**double *pLamData**: The pLamData array stores the wavelength for each data point in the trace. **double *pPowData**: The pPowData array stores the measured power levels (dB scale) for each point in the trace. Each point from the pPowData array has a corresponding point in the pLamData array. **unsigned short dataSize**: This is the size of arrays pLamData and pPowData allocated by the user. This is the size of the acquired trace retrieved by the user with the function getDataSize. **unsigned short refpeak**: This is an integer type that has the following set of values: {MAX_PEAK_REF = 0, MIN_PEAK_REF = 1} **double interLevel**: The interpolation level is the height from the peak where the bandwidth is

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Function	Description
	calculated. **unsigned short baseref**: This is Boolean. For minimum peaks, the baseref is 1 and the bandwidth of the peak is calculated from the base of the peak. For maximum peaks, the baseref is 0 and the bandwidth is calculated from the peak.
Output	**double *pCenLam**: pCenLam stores the center wavelength of the peak. **double *pCenPow**: pCenPow stores the center power of the peak corresponding to center wavelength.
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

writeLED

Function	Description
Purpose	The writeLED function is used to write a string of characters to the LED display of a selected channel.
C prototype	int writeLED(unsigned short chID, char *atext)
VB prototype	Declare Function writeLED Lib "SWS15100" (ByVal chID%, ByVal atext$) As Long
Input	**unsigned short chID**: This is the channel selected for writing. **char *atext**: This is a string that the user writes to the channel's LED. The string must have exactly four characters.
Output	None
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

blinkLED

Function	Description
Purpose	The blinkLED function is used to control the blink of the LED display of the selected channel.
C prototype	int blinkLED(unsigned short chID, unsigned short OnOff)

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Function	Description
VB prototype	Declare Function blinkLED Lib "SWS15100" (ByVal chID%, ByVal OnOff%) As Long
Input	**unsigned short chID**: This is the channel selected for blinking. **unsigned short OnOff**: This is Boolean. When the value is 1, blinking is turned ON. When the value is 0, blinking is disabled. The previous state is irrelevant.
Output	None
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

setPolarizationControl

Function	Description
Purpose	The setPolarizationControl function is used to set a flag that enables or disables operations involving any polarization related function.
C prototype	int setPolarizationControl(short polarFlag)
VB prototype	Declare Function setPolarizationControl Lib "SWS15100" (ByVal polarFlag%) As Long
Input	**short polarFlag**: To detect at the receiver side all polarization states sent by the transmitter, the polarFlag value must be 1. If the polarFlag value is 0, any polarization sent by the transmitter is seen as polarization state S0.
Output	None
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

getPolarizationControl

Function	Description
Purpose	The getPolarizationControl function is used to get the status of the polarization flag.
C prototype	int getPolarizationControl( )
VB prototype	Declare Function getPolarizationControl Lib "SWS15100" () As Long
Input	None
Output	None

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Function	Description
Return Value	When there is no error, the function returns the value of the polarFlag as set by the function setPolarizationControl ( ). When there is an error, the return value contains the error number.

isDarkVoltageDone

Function	Description
Purpose	The isDarkVoltageDone function is used to check if a dark voltage measurement has been performed for the specified channel.
C prototype	int isDarkvolatgeDone(unsigned short chID, char *timeStamp)
VB prototype	Declare Function isDarkVoltageDone Lib "SWS15100" (ByVal chID%, ByVal timeStamp$) As Long
Input	**unsigned short chID**: This is the channel to be checked.
Output	**char *timeStamp**: This is the time of the last zero loss reference for the specified polarization. At least 32 characters must be assigned to this array.
Return Value	When a dark voltage measurement has been done for the specified channel, the return value is 1 (TRUE). When a dark voltage measurement has been done for the specified channel, the return value is 0 (FALSE). When there is an error, the return value contains the error number.

getAverageDarkVoltagePower

Function	Description
Purpose	The getAverageDarkVoltagePower function is used to get the average power measured during a dark voltage measurement. This function is called after the dark voltage measurement for the specified channel has been performed.
C prototype	int getAverageDarkVoltagePower(unsigned short chID, double *dAvePower)
VB prototype	Declare Function getAverageDarkVoltagePower Lib "SWS15100" (ByVal chID%, ByRef dAvePower As Double) As Long
Input	**unsigned short chID**: This is the channel number.
Output	**double *dAvePower**: This is the average dark voltage power in dBm.
Return Value	If there is no error, the return value is 0. If there is an error, the return value contains the error number.

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getChannelPolarization

Function	Description
Purpose	The getChannelPolarization function retrieves the polarization of the trace for the specified channel in cache memory. Note: This function returns the last polarization for specified channel, the last time any data was collected for the channel. To find the latest polarization, use getTracePolarization instead.
C prototype	int getChannelPolarization(unsigned short chID, short *polar);
VB prototype	Declare Function getChannelPolarization Lib "SWS15100" (ByVal ChID%, ByRef polar%) As Long
Input	**Unsigned short chID:** Channel ID for which polarization is sought.
Output	**short *polar**: This is a set of integers defined as: { S0 = 0, S1 = 1, S2 = 2, S3 = 3, S4 = 4, POLARIZATION_END_MARKER = 5 }.
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

isZeroLossDone

Function	Description
Purpose	The isZeroLossDone function is used to check if a zero loss reference has been performed for the specified polarization on the specified channel.
C prototype	int isZeroLossDone(unsigned short chID, short polar, char *timeStamp)
VB prototype	Declare Function isZeroLossDone Lib "SWS15100" (ByVal chID%, ByVal polar%, ByVal timeStamp$) As Long
Input	**unsigned short chID**: This is the channel to be checked. **short polar**: This is the polarization state for which the user checks for zero loss reference.
Output	**char *timeStamp**: This is the time of the last zero loss reference for the specified polarization.
Return Value	When there is a zero loss reference done for the specified polarization, the return value is 1 (TRUE). When there is no zero loss reference done for the specified polarization, the return value is 0 (FALSE). When there is an error, the return value contains the error number.

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getPDLReferences

Function	Description
Purpose	The getPDLReferences function is used to get the references (zero loss) for all four polarization states (S1, S2, S3, and S4) used to calculate the PDL of a device. This function automatically acquires all four references for each of the four polarization states. If one of the polarization states is not detected in a specified amount of time, the function returns a timeout error.
C prototype	int getPDLReferences(unsigned short chID);
VB prototype	Declare Function getPDLReferences Lib "SWS15100" (ByVal chID%) As Long
Input	**unsigned short chID**: This is the channel selected for acquiring all four references.
Output	None
Return Value	If there is no error and all four references (for each of the four polarization states) are properly acquired, the return value is 0. If there is an error, the return value contains the error number.

acquirePDL

Function	Description
Purpose	The acquirePDL function is used to get the IL data for all four polarization states (S1, S2, S3, and S4) and for all the channels on the user list. One call to this function is used to acquire only one polarization (one IL) set of data. This function must be called for each of the four polarization states to obtain a full set of IL data required for a PDL calculation. The parameter hStartPDL is used as a flag to indicate the acquisition of new data. To acquire a new set of data, the user must set the hStartPDL value to 1(TRUE). To acquire a complete IL data set, all the other calls to this function use the value 0(FALSE) for hStartPDL. The function returns 0 if the PDL acquisition is not finished. It returns 1 if the PDL acquisition is completed and a PDL processing can be started. It returns an error number if there is any error. For this function to work, a zero loss reference is done for each polarization state prior to the call to acquirePDL.
C prototype	int acquirePDL(unsigned short *chList, unsigned short uhNumChannels, short hStartPDL)
VB prototype	Declare Function acquirePDL Lib "SWS15100" (ByRef chList%, ByVal numChannels%, ByVal startPDL%) As Long
Output	None

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Function	Description
Return Value	If there is no error and another IL data value has been acquired, but PDL acquisition is not yet finished, the return value is 0. If there is no error and all four IL sets of data (for all four polarization states) have been properly acquired, the return value is 1. If there is an error, the return value contains the error number.

processPDL

Function	Description
Purpose	The processPDL function is used to calculate the PDL for all the channels in the user list. The user acquires the IL data for all channels in the channel list through calls to the acquirePDL function. If one of the four sets of required IL data (S1, S2, S3, or S4) or one channel data value is missing, the function returns an error.
C prototype	int processPDL(unsigned short *chList, unsigned short uhNumChannels)
VB prototype	Declare Function processPDL Lib "SWS15100" (ByRef chList%, ByVal numChannels) As Long
Input	**unsigned short *chList**: This is the list of channels selected for acquiring all four references. **unsigned short uhNumChannels**: This is the number of channels in the list.
Output	None
Return Value	If there is no error, the return value is 0. If there is an error, the return value contains the error number.

getPDLTrace

Function	Description
Purpose	The getPDLTrace function is used to get the PDL traces for a specific channel. This function is called after a call to the processPDL function.
C prototype	int getPDLTrace(unsigned short chID, double *dLam, double *dPowMin, double *dPowMax, double *dPowAve, double *dPowPdl, unsigned short *uhDataSize)
VB prototype	Declare Function getPDLTrace Lib "SWS15100" (ByVal chID%, ByRef dLam As Double, ByRef powMin As Double, ByRef powMax As Double, ByRef powAve As Double, ByRef powPdl As Double, ByRef dataSize%) As Long
Input	**unsigned short chID**: This is the channel number.

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Function	Description
Output	**double *dLam**: This is the array of the wavelength position points. **double *dPowMin**: This is the array of the minimum IL data (IL_MIN). **double *dPowMax**: This is the array of the maximum IL data (IL_MAX). **double *dPowAve**: This is the array of the average IL data (IL_AVE). **double *dPowPdl**: This is the array of the PDL data. **unsigned short *uhDataSize**: This is the size of the data that is sent back to the user inside the data arrays.
Return Value	If there is no error, the return value is 0. If there is an error, the return value contains the error number.

getAverageZeroLossPower

Function	Description
Purpose	The getAverageZeroLossPower function is used to get the average power measured during a zero loss measurement. This function is called after the zero loss reference for that specified polarization state and channel has been performed.
C prototype	int getAverageZeroLossPower(unsigned short chID, short hPolar, double *dAvePower)
VB prototype	Declare Function getAverageZeroLossPower Lib "SWS15100" (ByVal chID%, ByVal hPolar%, ByRef dAvePower As Double) As Long
Input	**unsigned short chID**: This is the channel number. **short hPolar**: This is the polarization needed for the average zero loss power.
Output	**double *dAvePower**: This is the average zero loss power.
Return Value	If there is no error, the return value is 0. If there is an error, the return value contains the error number.

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getLocalPeakPower

Description	The getlocalPeakPower function retrieves the power of the largest peak that is contained in the pPowData power array, within a specified wavelength range. Call the function after obtaining pPowData array through a call to the getILTrace function. The refpeak parameter must be specified by the caller.
C prototype	int getLocalPeakPower(double *pLamData, double *pPowData, unsigned short dataSize, double dStartWave, double dStopWave, unsigned short refpeak, unsigned short *peakIndex, double *pPowPeak, double *pLamPeak);
VB prototype	Declare Function getLocalPeakPower Lib "SWS15100" (ByRef pLamData As Double, ByRef pPowData As Double, ByVal dataSize%, ByVal dStartWave As Double, Byval dStopWave As Double, ByVal refPeak%, ByRef PeakIndex%, ByRef pPowPeak As Double, ByRef pLamPeak As Double) As Long
Input	**double *pLamData**: The pLamData array stores wavelength points of the trace. **double *pPowData**: The pPowData array stores IL power level (dB scale) points. Each point from the pPowData array has a corresponding point in the pLamData array. **unsigned short dataSize**: This is the size of arrays pLamData and pPowData allocated by the user. This is the size of the acquired trace retrieved by the user using the function getDataSize. **double dStartWave**: Specifies the wavelength at which to start processing. **double dStopWave**: Specifies the wavelength at which to stop processing.
Output	**unsigned short refpeak**: This is an integer set of values: {MAX_PEAK_REF = 0(find maximum peaks), MIN_PEAK_REF = 1(find minimum peaks)} **unsigned short *peakIndex** This is the position of the peak in the pPowData array. **double *pPowPeak**: This is the power of the peak, the maximum power of the pPowData array, within the wavelength range specified. **double *pLamPeak**: This is the wavelength of the peak that corresponds to the pPowPeak value.
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

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getLocalBandwidth

Description	The getLocalBandwidth function calculates the bandwidth of the largest peak that is contained in the pPowData power array, within a specified wavelength range. Call this function only after obtaining the pPowData array through a call to the getILTrace function. The characteristics of the peak as refpeak, interLevel, and baseref must be filled by the caller.
C prototype	int getLocalBandwidth(double *pLamData, double *pPowData, unsigned short dataSize, double dStartWave, double dStopWave, unsigned short refpeak, double interLevel, unsigned short baseRef, double *pBandwidth);
VB prototype	Declare Function getLocalBandwidth Lib "SWS15100" (ByRef pLamData As Double, ByRef pPowData As Double, ByVal dataSize%, ByVal dStartWave As Double, ByVal dStopWave As Double, ByVal refPeak%, ByVal InterLevel As Double, ByVal baseRef%, ByRef pBandwidth As Double) As Long
Input	**double *pLamData**: The pLamData array stores wavelength points of the trace. **double *pPowData**: The pPowData array stores IL power level (dB scale) points. Each point from the pPowData array has a corresponding point in the pLamData array. **unsigned short dataSize**: This is the size of arrays pLamData and pPowData allocated by the user and is the size of the acquired trace returned by the function getDataSize. **double dStartWave**: This specifies the wavelength at which to start processing. **double dStopWave**: This specifies the wavelength at which to stop processing. **unsigned short refpeak**: This is an integer type that has the following set of values: {MAX_PEAK_REF = 0, MIN_PEAK_REF = 1}. **double interLevel**: The interpolation level is the height from the peak where the bandwidth is calculated. **unsigned short baseRef**:: This is Boolean. For minimum peaks, the baseRef is 1 and the bandwidth of the peak is calculated from the base of the peak. For maximum peaks, the baseRef is 0 and the bandwidth is calculated from the peak.
Output	**double *pBandwidth**: The pBandwidth stores the bandwidth of the peak within the wavelengths dStartWave and dStopWave.
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

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getLocalCenterWave

Description	The getLocalCenterWave function calculates the center wavelength and its corresponding power for the largest peak that is contained in the pPowData array, within a specified wavelength range. This function must be called only after the user has obtained the pPowData and pLamData arrays through a call to the getILTrace function. The parameters refpeak and interLevel must be supplied by the caller.
C prototype	int getLocalCenterWave(double *pLamData, double *pPowData, unsigned short dataSize, double dStartWave, double dStopWave, unsigned short refpeak, double interLevel, unsigned short baseRef, double *pCenLam, double *pCenPow);
VB prototype	Declare Function getLocalCenterWave Lib "SWS15100" (ByRef pLamData As Double, ByRef pPowData As Double, ByVal dataSize%, ByVal dStartWave As Double, ByVal dStopWave As Double, ByVal refPeak%, ByVal InterLevel As Double, ByVal baseRef%, ByRef pCenLam As Double, ByRef pCenPow As Double) As Long
Input	**double *pLamData**: The pLamData array stores wavelength points of the trace. **double *pPowData**: The pPowData array stores IL power level (dB scale) points. Each point from the pPowData array has a corresponding point in the pLamData array. **unsigned short dataSize**: This is the size of arrays pLamData and pPowData allocated by the user. This is the size of the acquired trace retrieved by the user with the function getDataSize. **double dStartWave**: This specifies the wavelength at which to start processing. **double dStopWave**: This specifies the wavelength at which to stop processing. **unsigned short refpeak**: This is an integer type that has the following set of values: {MAX_PEAK_REF = 0, MIN_PEAK_REF = 1}. **double interLevel**: The interpolation level is the height from the peak where the bandwidth is calculated. **unsigned short baseref**: This is Boolean. For minimum peaks, the baseref is 1 and the bandwidth of the peak is calculated from the base of the peak. For maximum peaks, the baseref is 0 and the bandwidth is calculated from the peak.

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Output	**double *pCenLam**: pCenLam stores the center wavelength of the peak. **double *pCenPow**: pCenPow stores the center power of the peak corresponding to the center wavelength within the specified wavelength.
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

setBand

Description	The setBand function sets the band for the next trace. The call to this function switches the dual band selector module to collect data from the appropriate transmitter.
C prototype	Int setBand(unsigned short uhBand);
VB prototype	Declare Function setBand Lib "SWS15100" (ByVal uhBand%) AS BOOLEAN
Inputs	**Unsigned short uhBand**: let uhBand = 1 for Band C and 2 for L Band, are valid inputs for the wavelength band.
Outputs	Return value: When there is no error, the function returns zero. When there is an error, the function returns an error number.

getPassBand

Description	The getPassBand function computes the passband of the largest peak contained in the pPowData power array. Call the function after obtaining pPowData array through a call to the getILTrace function. The refpeak parameter must be specified by the caller.
C prototype	int getPassBand(double *pdLamData, double *pdPowData, unsigned short dataSize, unsigned short refPeak, unsigned short baseRef, double interLevel, unsigned short refWave, double *pdPassBand);
VB prototype	Declare Function getPassBand Lib "SWS15100" (ByRef pLamData As Double, ByRef pPowData As Double, ByVal dataSize%, ByVal refPeak%, ByVal baseRef%, ByVal interLevel as Double, ByVal refWave%, ByRef pdPassBand As Double) As Long

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Input	**Double *pLamData**: The pLamData array stores wavelength points of the trace. **Double *pPowData**: The pPowData array stores IL power level (dB scale) points. Each point from the pPowData array has a corresponding point in the pLamData array. **unsigned short dataSize**: This is the size of arrays pLamData and pPowData allocated by the user. This is the size of the acquired trace retrieved by the user using the function getDataSize. **unsigned short refpeak**: This is an integer set of values: {MAX_PEAK_REF = 0 (find maximum peaks), MIN_PEAK_REF = 1 (find minimum peaks)} **unsigned short baseref**: This is Boolean. For minimum peaks, the baseref is 1 and the bandwidth of the peak is calculated from the base of the peak. For maximum peaks, the baseref is 0 and the bandwidth is calculated from the peak. **double interLevel**: The interpolation level is the height from the peak where the bandwidth is calculated. **unsigned short uhRefWave:** This is the reference wavelength, or the nominal center wavelength around which the passband is computed.
Output	**unsigned double *pdPassBand:** This is the computed passband for the full wavelength range. Return value: When there is no error, the function returns zero. When there is an error, the return value contains the error number.

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getLocalPassBand

Description	The getLocalPassBand function computes the passband of the largest peak contained in the pPowData power array, within a specified wavelength range. Call the function after obtaining pPowData array through a call to the getILTrace function. The refpeak parameter must be specified by the caller.
C prototype	int getLocalPassBand(double *pdLamData,double *pdPowData,unsigned short dataSize,double dStartWave,double dStopWave,unsigned short refPeak,unsigned short baseRef,double InterLevel, unsigned short refWave, double *pdPassBand);
VB prototype	Declare Function getLocalPassBand Lib "SWS15100" (ByRef pLamData As Double, ByRef pPowData As Double, ByVal dataSize%, ByVal dStartWave As Double, ByVal dStopWave As Double, ByVal refPeak%, ByVal baseRef%, ByVal interLevel as Double, ByVal refWave%, ByRef pdPassBand As Double) As Long
Input	**double *pLamData**: The pLamData array stores wavelength points of the trace. **double *pPowData**: The pPowData array stores IL power level (dB scale) points. Each point from the pPowData array has a corresponding point in the pLamData array. **unsigned short dataSize**: This is the size of arrays pLamData and pPowData allocated by the user. This is the size of the acquired trace retrieved by the user using the function getDataSize. **double dStartWave**: Specifies the wavelength at which to start processing. **double dStopWave**: Specifies the wavelength at which to stop processing. **unsigned short refpeak**: This is an integer set of values: {MAX_PEAK_REF = 0 (find maximum peaks), MIN_PEAK_REF = 1 (find minimum peaks)} **unsigned short baseref**: This is Boolean. For minimum peaks, the baseref is 1 and the bandwidth of the peak is calculated from the base of the peak. For maximum peaks, the baseref is 0 and the bandwidth is calculated from the peak.

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	double interLevel: The interpolation level is the height from the peak where the bandwidth is calculated. **unsigned short uhRefWave**: This is the reference wavelength, or the nominal center wavelength around which the passband is computed.
Output	**unsigned short *pdPassBand:** This is the computed passband in the wavelength range specified.
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

getFlatness

Description	The getFlatness function computes the flatness of the trace in the pPowData power array, within a specified wavelength range. Call the function after obtaining pPowData array through a call to the getILTrace function. The refpeak parameter must be specified by the caller.
C prototype	int getFlatness(double *pLamData, double *pPowData, unsigned short uhDataSize, double dStartWave, double dStopWave, double *pdPowFlatness);
VB prototype	Declare Function getLocalPassBand Lib "SWS15100" (ByRef pLamData As Double, ByRef pPowData As Double, ByVal uhDataSize%, ByVal dStartWave As Double, Byval dStopWave As Double, ByRef pdPowFlatness As Double) As Long
Input	**double *pLamData**: The pLamData array stores wavelength points of the trace. **double *pPowData**: The pPowData array stores IL power level (dB scale) points. Each point from the pPowData array has a corresponding point in the pLamData array. **unsigned short dataSize**: This is the size of arrays pLamData and pPowData allocated by the user. This is the size of the acquired trace retrieved by the user using the function getDataSize. **double dStartWave**: Specifies the wavelength at which to start processing. **double dStopWave**: Specifies the wavelength at which to stop processing.
Output	**unsigned short *pdPowFlatness:** This is the computed flatness in the wavelength range specified.

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Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

getITUSize

Description	The function getITUSize returns the number of ITU channels between specified wavelengths or frequencies.
C prototype	int getITUSize(double dITUSpaceInGHz, double dStartWave, double dStopWave, unsigned short uhITUunits);
VB prototype	Declare Function getITUSize Lib "SWS15100" (ByVal dITUSpaceINGHz As Double, ByVal dStartWave As Double, Byval dStopWave As Double, ByVal uhITUunits%) As Long
Input	**double dITUSpaceInGHz**: Specifies the spacing of ITU channels. This must be in GHz. **double dStartWave**: Specifies the start wavelength or frequency. **double dStopWave**: Specifies the stop wavelength or frequency. **unsigned short uhITUunits**: This integer specifies the units for the stop and start wavelength or frequency. The allowed values are UNITS_NM and UNITS_GHZ, specified in the file swsConst.h.
Output	None
Return Value	When there is no error, the function returns the number of ITU channels. When there is an error, the return value contains the error number.

getITU

Description	The getITU function returns the current ITU grid in a specified wavelength or frequency range.
C prototype	int getITU(double dITUSpaceInGHz, double dStartWave, double dStopWave, unsigned short uhITUunits, double *pdITUGrid);
VB prototype	Declare Function getITU Lib "SWS15100" (ByVal dITUSpaceInGHz As Double, ByVal dStartWave As Double, Byval dStopWave As Double, ByVal uhITUunits%, ByRef pdITUGrid As Double) As Long
Input	**unsigned short dITUSpaceInGHz**: This is the spacing of ITU channels in GHz; for example, 50 or 100 GHz.

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	double dStartWave: Specifies the start wavelength or frequency. **double dStopWave**: Specifies the stop wavelength or frequency. **unsigned short uhITUunits**: This is either UNITS_NM or UNITS_GHZ. This tells the function how to interpret the start and stop wavelength or frequency.
Output	**double *pdITUGrid**: The ITUGrid, in terms of wavelengths, that mark the start of a new ITU channel, are returned in the array. The values returned are in the units specified by uhITUunits.
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

getCrossTalk

Description	The getCrossTalk function computes the power levels required to compute the crosstalk. Call the function after obtaining pPowData array through a call to the getILTrace function.
C prototype	int getCrossTalk(double *adLamData, double *adPowData, unsigned short uhDataSize, double dRefWave, unsigned short uhListSize, double *pdLamOutWaveList, double dBandWidth, double *pdInPowPeak, double *pdLeftOutPower, double *pdRightOutPower, double *pdTotalOutPower);
VB prototype	Declare Function getCrossTalk Lib "SWS15100" (ByRef adLamData As Double, ByRef adPowData As Double, ByVal uhDataSize%, ByVal dRefWave As Double, ByVal uhListSize%, ByRef pdLamOutWaveList As Double, ByVal dBandWidth As Double, ByRef pdInPowPeak As Double, ByRef pdLeftOutPower As Double, ByRef pdRightOutPower As Double, ByRef pdTotalOutPower As Double) As Long
Input	**double *pLamData**: The adLamData array stores wavelength points of the trace. **double *pPowData**: The adPowData array stores IL power level (dB scale) points. Each point from the pPowData array has a corresponding point in the pLamData array. **unsigned short dataSize**: This is the size of arrays pLamData and pPowData allocated by the user. This is the size of the acquired trace retrieved by the user using the function getDataSize. **double dRefWave**: Specifies the wavelength relative to which crosstalk is calculated, or the

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	reference wavelength. **unsigned short uhListSize**: This specifies the size of the array containing the out-of-band wavelengths. **double *pdLamOutWaveList**: This is the array of out-of-band wavelengths for which crosstalk is calculated. **double dBandWidth**: This specifies the bandwidth within which to compute peak powers around each out-of-band wavelength.
Output	**double *pdInPowPeak:** This is the peak power in the in-band channel. The peak is found around the reference wavelength, going a half-bandwidth on either side. **double *pdLeftOutPower:** This is the power in the out-of-band channel to the left of the reference wavelength. **double *pdRightOutPower:** This is the power in the out-of-band channel to the right of the reference wavelength. **double *pdTotalOutPower:** This is the total power in the out-of-band channels.
Return Value	When there is no error, the function returns zero. When there is an error, the return value contains the error number.

getChannelList

Function	**Description**
Purpose	The getChannelList function retrieves all the channels present on the SWS system. Values are returned in an array list. The size of the array must be 128. The active channels are filled from the beginning of the array. The rest of the array, up to 128, is filled with 0. To work properly, this function must have an array of 128 unsigned short elements allocated for the active channel list.
C prototype	unsigned short getChannelList(unsigned short *channelList);
VB prototype	Declare Function getChannelList Lib "SWS15100" (ByRef channelList%) As Long
Input	**Unsigned short *channelList**: The channelList array contains all the channels that are present on the SWS system.

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Function	Description
Output	None
Return Value	When there is no error, the function returns the number of active channels detected and updates the channel list array. When there is an error, the function returns an error number.

getOWBInfo

Function	Description
Purpose	The getOWBInfo function retrieves the factory information pertaining to a physical channel.
C prototype	int getOWBInfo(unsigned short chID, short *bPresent, char *acID, char *acSN, char *acREV, char *acDESC);
VB prototype	Declare Function getOWBInfo Lib "SWS15100" (ByVal chID%, ByRef bPresent%, ByVal acID$, ByVal acSN$, ByVal acREV$, ByVal acDESC$) As Long
Input	**unsigned short chID**: This is the channel ID that the user selects to query for information. To retrieve the information related to the control module, the channel ID must be 0.
Output	**short *bPresent**: When bPresent is 1, then channel chID is present. When bPresent is zero, the channel hardware does not exist. **char *acID**: This is a string of size MAX_ID_LEN (9) that contains the module identification. **char *acSN**: This is a string of size MAX_SN_LEN (17) that contains the serial number. **char *acREV**: This is a string of size MAX_REV_LEN (9) that contains the revision number. **char *acDESC**: This is a string of size MAX_DESC_LEN (41) that contains the description. Constants MAX_ID_LEN, MAX_SN_LEN, MAX_REV_LEN, and MAX_DESC_LEN are defined in the SWS15100.H file.
Return Value	When all required information has been successfully retrieved, the function returns a zero.

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Function	Description
	When there is any error in information retrieval, the function returns an error number.

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setUnits

Description	The setunits function sets the units for the X-axis to either nm or GHz, and the Y-axis to dB or linear (%).
C prototype	void setUnits(unsigned short uhXunits, unsigned short uhYunits);
VB prototype	Declare Function setUnits Lib "SWS15100" (ByVal uhXunits%, ByVal uhYunits%,)
Inputs	**unsigned short uhXunits**: Two constants, UNITS_NM and UNITS_GHZ, are valid inputs for the X units. **unsigned short uhYunits**: Two constants, UNITS_DB and UNITS_PERCENT, are valid inputs for the Y units.
Outputs	None
Return Value	When there is no error, the function returns zero. When there is an error, the function returns an error number.

getUnits

Description	The getunits function finds the current units for the X-axis (either nm or GHz) and the Y-axis (dB or linear (%)).
C prototype	void getUnits(unsigned short *uhXunits, unsigned short *uhYunits);
VB prototype	Declare Function getUnits Lib "SWS15100" (ByRef uhXunits%, ByRef uhYunits%,)
Inputs	None
Outputs	**unsigned short *uhXunits**: One of two constants, UNITS_NM and UNITS_GHZ, are returned for the X units. **unsigned short *uhYunits**: One of two constants, UNITS_DB and UNITS_PERCENT, are returned for the Y units.
Return Value	When there is no error, the function returns zero. When there is an error, the function returns an error number.

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terminateSWS

Description	The terminateSWS function terminates the SWS operation and resets all hardware.
C prototype	void terminateSWS();
VB prototype	Declare Function terminateSWS Lib "SWS15100" () As Long
Inputs	None
Outputs	None
Return Value	None

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DLL Error Returns

Table 19 lists the error messages that can be returned by the functions.

Table 19: DLL Error Messages

Code	Description
0	SUCCESS
-1	INDEX_UNDER_ZERO
-2	INDEX_OVER_TRACESIZE
-3	MEM_ALLOC_FAILED
-4	M0L_CALCUL_ERROR
-5	NO_COLLECTED_DATA
-6	POW_CAL_ERROR
-7	WAVE_CAL_ERROR
-8	SET_PCAL_ERROR
-9	GET_PCAL_ERROR
-10	SET_M0L_ERROR
-11	GET_M0L_ERROR
-12	NOT_ENOUGH_POINTS
-13	CHANNEL_NO_DATA
-14	PEAK_NOT_FOUND
-15	INTERPOLATION_ERROR
-16	INVALID_DATA_VALUE
-17	INVALID_ZERO_LOSS
-18	REQUEST_SCAN_ERROR
-19	REQUEST_AVERAGE_ERROR
-20	REQUEST_OWBINFO_ERROR
-21	RESET_COUNTER_TIMEOUT
-22	TRIGGER_TRACE_TIMEOUT
-23	WRITE_CACHE_ERROR
-24	READ_CACHE_ERROR
-25	DATA_PROCESS_ERROR
-26	INVALID_ZEROLOSS_DATA

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Code	Description
	(table continued)
-27	BLINK_LED_ERROR
-28	WRITE_LED_ERROR
-29	INVALID_INPUT_DATA
-30	INVALID_IL_TRACE
-31	ACQUIRE_PDL_TIMEOUT
-32	INVALID_PDL_ACQUISITION
-33	POLARIZATION_FLAG_OFF
-34	DV_TOO_MUCH_LIGHT

Programming Examples

Contents of CD-ROM

The following files and folders are displayed in the SWS15100 directory when the SWS software is installed:

- \Analysis—Folder reserved for results of data analysis
- \Cache—Folder reserved for raw data files required during data collection
- \DarkVoltage—Folder reserved for results of dark voltage measurements
- \Development—Folder containing examples of Visual Basic (VB) and Visual C++ using the SWS15100 DLL. These examples can be used as templates for the development of specialized application programs.
- \Data – Default storage location for saved data sets from the measurement results.
- \Documentation – Folder containing soft copies of the documentation accompanying SWS.
  - \Development\SWS15100.dll—Dynamic Link Library required to control the acquisition and processing of raw data
  - \Development\examples\C\SWS15100.h—Header file containing declarations of functions and global constants
- \ILCacheC—Folder reserved for trace data for the channels in IL mode and C-band
- \ILCacheL—Folder reserved for trace data for the channels in IL mode and L-band
- \PDLCacheC—Folder reserved for trace data for the channels in PDL mode and C-band
- \PDLCacheL—Folder reserved for trace data for the channels in PDL mode and L-band
- \RefDataC—Folder reserved for reference data for the channels in C-band
- \RefDataL—Folder reserved for reference data for the channels in L-band
- \Reference—Folder reserved for control module reference data
- \Workspace—Folder used to store workspace data
- _deisreg.isr—System utility
- _isreg32.dll—System utility
- OWB1.dll—Folder reserved for results of data analysis
- OWB2.dll—Folder reserved for results of data analysis
- OWB3.dll—Folder reserved for results of data analysis

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- Readme.txt—Folder reserved for results of data analysis
- SOM Access on COM1—Shortcut to SOMAccess on COM1
- SOM Access on COM2—Shortcut to SOMAccess on COM2
- SOM Access on COM3—Shortcut to SOMAccess on COM3
- SOM Access on COM4—Shortcut to SOMAccess on COM4
- SOMAccess.exe—Utility to set specific parameters on the SOM
- SWS15100.exe—SWS application program
- SWSBaseIOAddr.exe—Utility to set the base I/O address of the parallel port interface or data acquisition card
- SWS_SetupTestWizard.exe – Utility allowing verification of the test setup configuration

Visual Basic Programming Example

To run the VB example:

1. Copy OWB1.dll, OWB2.dll, OWB3.dll, and SWS15100.dll to the Windows\System directory in Windows 95/98, or to the \WinNT\System32 directory in Windows NT.

2. From the \Development\VB\Setup directory, run the setup.exe program.

3. From the \Development\VB\Source directory, run the SWSSample.exe program.

C Programming Example

To run the C programming example:

1. Edit the C program. In the call to initSWS, change the second parameter to the value of MaxPoints in the SWS15100.INI file.

2. Change the second parameter to the path for the sample program. The directory is used as the root directory for creating all associated SWS files and directories.

3. Recompile the program using any C compiler.

4. If any compiler other than a Microsoft compiler, such as Borland C or Borland C++, is being used for development, create a library compatible with the development system.

5. Link the program and run it.

If problems are experienced loading the DLLs, copy the DLLs to the \Windows\System or the \WinNT\System32 directory.

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Programming Flowcharts

To develop applications using the DLLs, refer to the VB and C code examples. The examples show how to call the low level routines that access the hardware. The following flowcharts (Figure 96 to Figure 104) show the steps required to acquire and process data in insertion loss and PDL modes.

The flowcharts are:

- Figure 96: SWS Data Collection and Processing
- Figure 97: Insertion Loss Mode Processing
- Figure 98: Zero Loss Data in Insertion Loss Mode
- Figure 99: Acquire Trace
- Figure 100: Get Insertion Loss
- Figure 101: Process Insertion Loss Trace
- Figure 102: PDL Mode Processing
- Figure 103: Zero Loss Data in PDL Mode
- Figure 104: Additional PDL Processing

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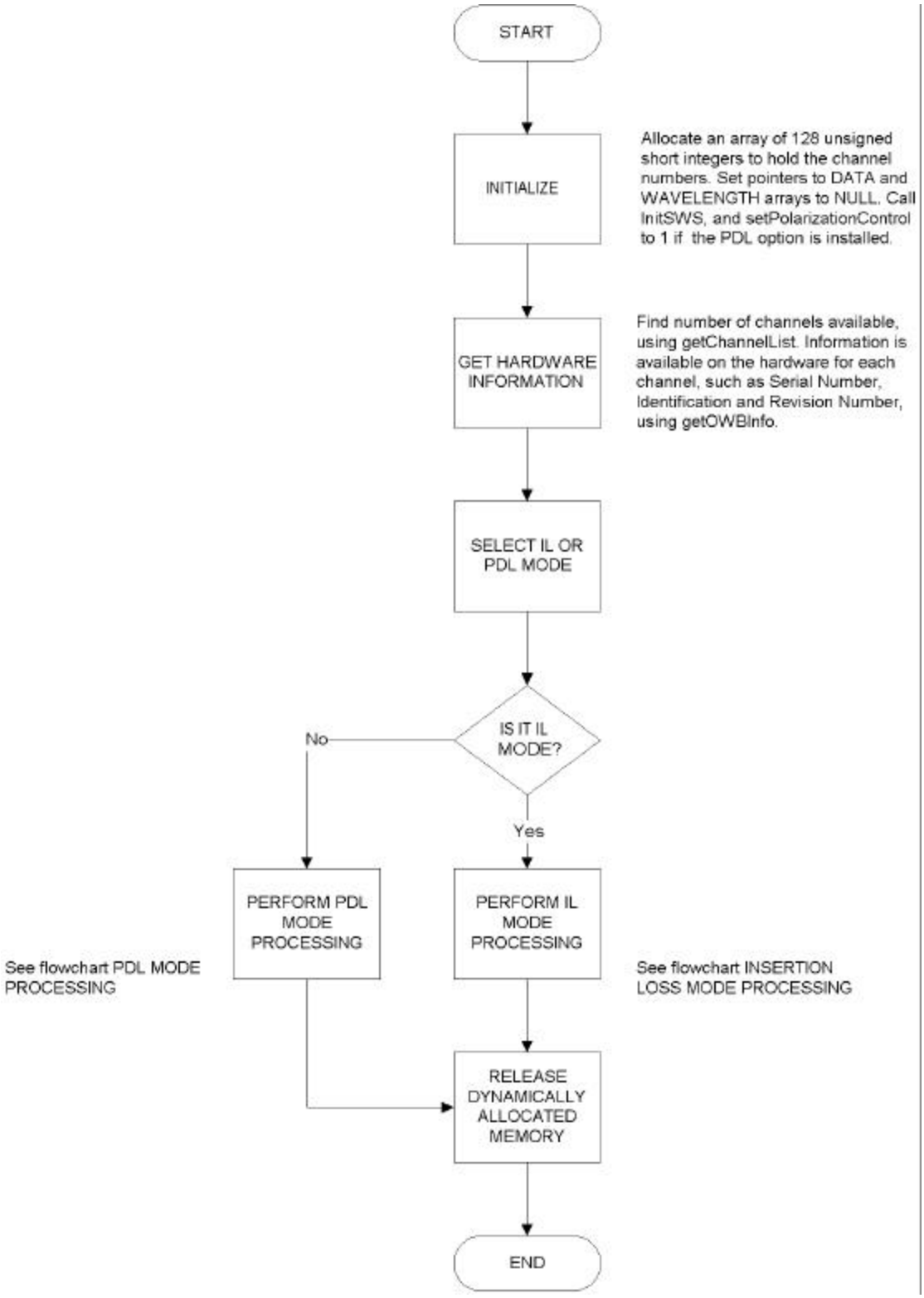
START
INITIALIZE
Allocate an array of 128 unsigned short integers to hold the channel numbers. Set pointers to DATA and WAVELENGTH arrays to NULL. Call InitSWS, and setPolarizationControl to 1 if the PDL option is installed.
GET HARDWARE INFORMATION
Find number of channels available, using getChannelList. Information is available on the hardware for each channel, such as Serial Number, Identification and Revision Number, using getOWBInfo.
SELECT IL OR PDL MODE
IS IT IL MODE?
No
Yes
PERFORM PDL MODE PROCESSING
PERFORM IL MODE PROCESSING
See flowchart PDL MODE PROCESSING
See flowchart INSERTION LOSS MODE PROCESSING
RELEASE DYNAMICALLY ALLOCATED MEMORY
END

Figure 96: SWS Data Collection and Processing

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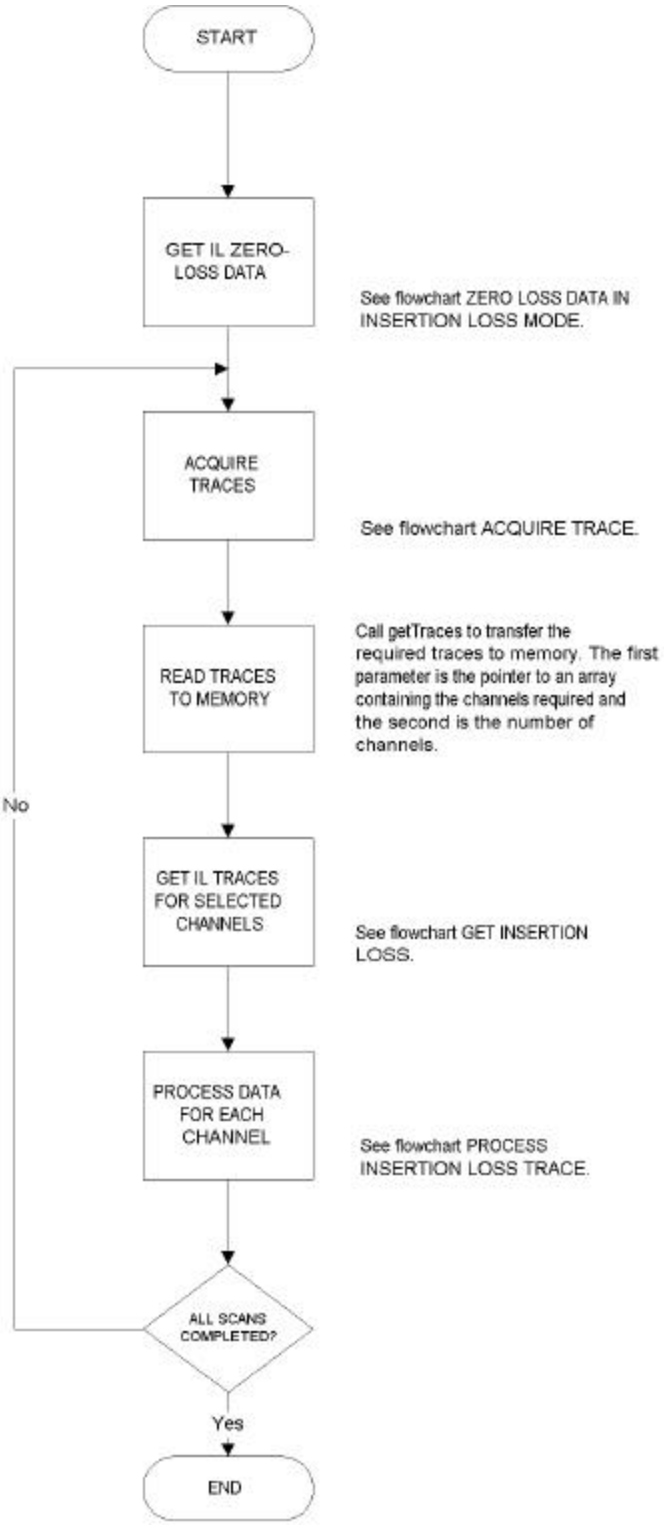
START
GET IL ZERO-LOSS DATA
See flowchart ZERO LOSS DATA IN INSERTION LOSS MODE.
ACQUIRE TRACES
See flowchart ACQUIRE TRACE.
READ TRACES TO MEMORY
Call getTraces to transfer the required traces to memory. The first parameter is the pointer to an array containing the channels required and the second is the number of channels.
No
GET IL TRACES FOR SELECTED CHANNELS
See flowchart GET INSERTION LOSS.
PROCESS DATA FOR EACH CHANNEL
See flowchart PROCESS INSERTION LOSS TRACE.
ALL SCANS COMPLETED?
Yes
END

Figure 97: Insertion Loss Mode Processing

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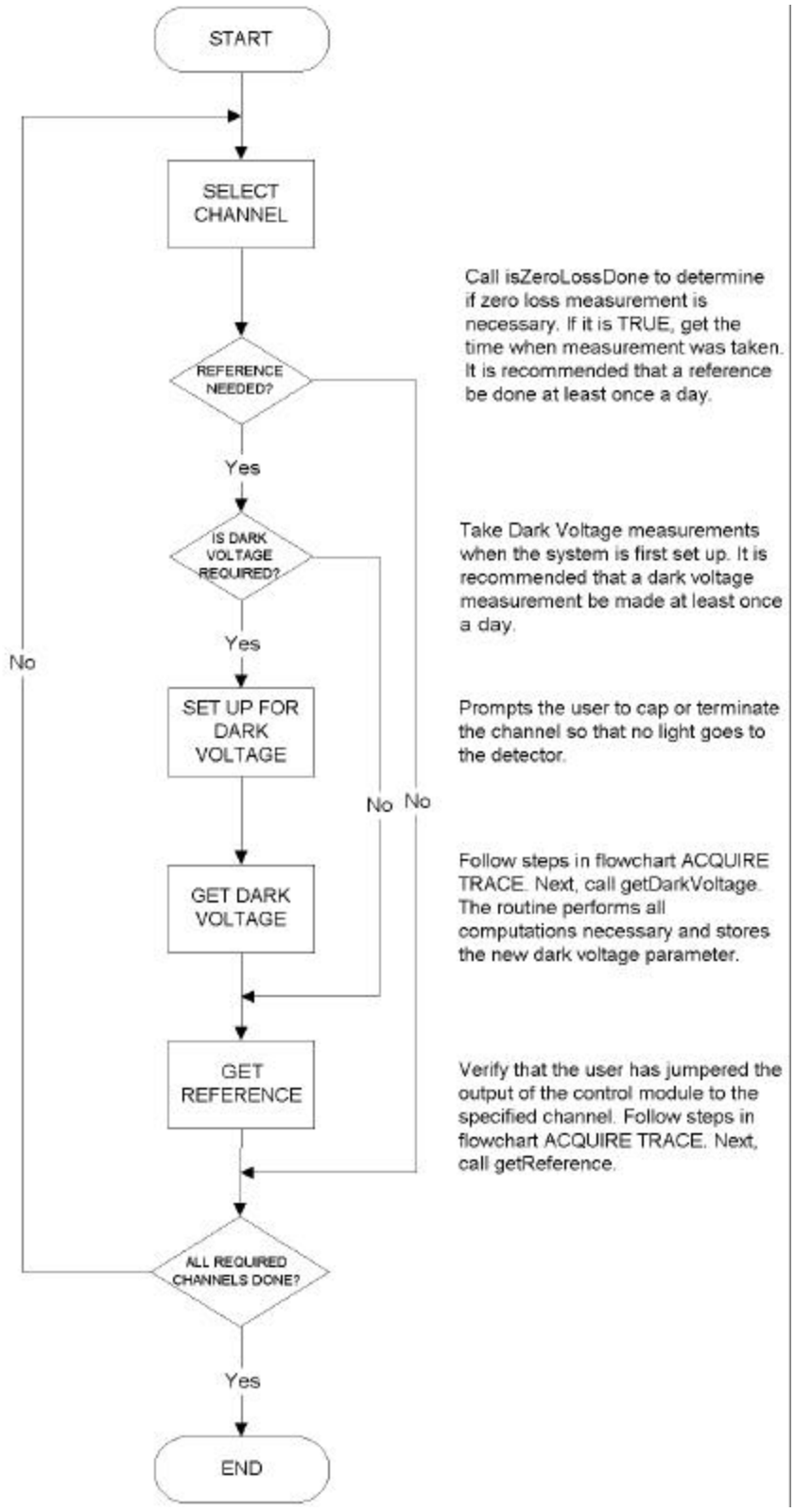
START
SELECT CHANNEL
REFERENCE NEEDED?
Yes
IS DARK VOLTAGE REQUIRED?
Yes
No
SET UP FOR DARK VOLTAGE
GET DARK VOLTAGE
GET REFERENCE
ALL REQUIRED CHANNELS DONE?
Yes
END
No
No
No
Call isZeroLossDone to determine if zero loss measurement is necessary. If it is TRUE, get the time when measurement was taken. It is recommended that a reference be done at least once a day.
Take Dark Voltage measurements when the system is first set up. It is recommended that a dark voltage measurement be made at least once a day.
Prompts the user to cap or terminate the channel so that no light goes to the detector.
Follow steps in flowchart ACQUIRE TRACE. Next, call getDarkVoltage. The routine performs all computations necessary and stores the new dark voltage parameter.
Verify that the user has jumpered the output of the control module to the specified channel. Follow steps in flowchart ACQUIRE TRACE. Next, call getReference.

Figure 98: Zero Loss Data in Insertion Loss Mode

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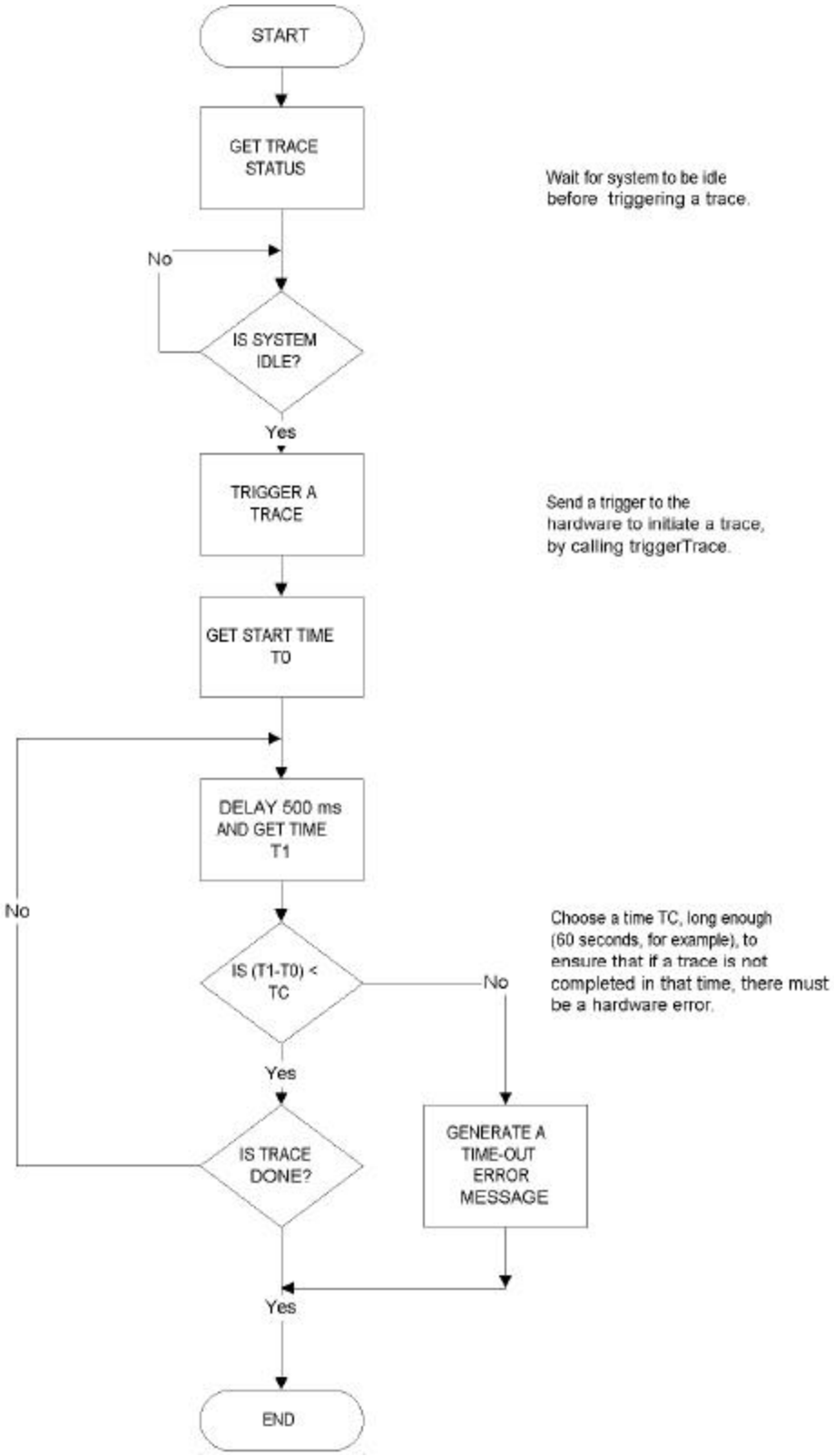
START
GET TRACE STATUS
Wait for system to be idle before triggering a trace.
No
IS SYSTEM IDLE?
Yes
TRIGGER A TRACE
Send a trigger to the hardware to initiate a trace, by calling triggerTrace.
GET START TIME T0
DELAY 500 ms AND GET TIME T1
No
IS (T1-T0) < TC
No
Choose a time TC, long enough (60 seconds, for example), to ensure that if a trace is not completed in that time, there must be a hardware error.
Yes
IS TRACE DONE?
GENERATE A TIME-OUT ERROR MESSAGE
Yes
END

Figure 99: Acquire Trace

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START
SELECT CHANNELS TO PROCESS
ACQUIRE A TRACE
Call getTraces, specifying channels.
GET DATA SIZE
All traces have the same length.
Is Data Size > 0?
No
Yes
ALLOCATE MEMORY FOR INSERTION LOSS TRACE
Allocate sufficient memory for an insertion loss trace and wavelength data. Each is an array of double floating point numbers of the length of a trace.
ISSUE HARDWARE ERROR MESSGE
GET IL TRACE
Call getILTrace in the memory allocated. The arrays are filled with insertion loss data in dB and corresponding wavelengths in nm.
No
PROCESS AS DESIRED
ALL REQUIRED CHANNELS COMPLETED?
Yes
FREE ALLOCATED MEMORY
END

Figure 100: Get Insertion Loss

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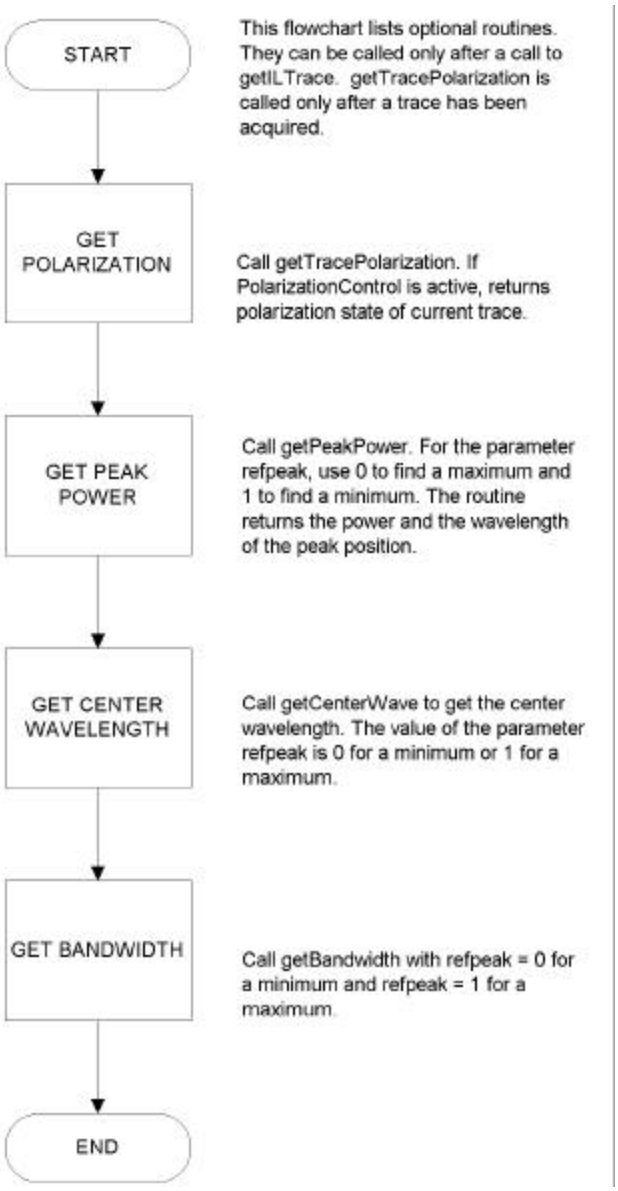
START
This flowchart lists optional routines. They can be called only after a call to getILTrace. getTracePolarization is called only after a trace has been acquired.
GET POLARIZATION
Call getTracePolarization. If PolarizationControl is active, returns polarization state of current trace.
GET PEAK POWER
Call getPeakPower. For the parameter refpeak, use 0 to find a maximum and 1 to find a minimum. The routine returns the power and the wavelength of the peak position.
GET CENTER WAVELENGTH
Call getCenterWave to get the center wavelength. The value of the parameter refpeak is 0 for a minimum or 1 for a maximum.
GET BANDWIDTH
Call getBandwidth with refpeak = 0 for a minimum and refpeak = 1 for a maximum.
END

Figure 101: Process Insertion Loss Trace

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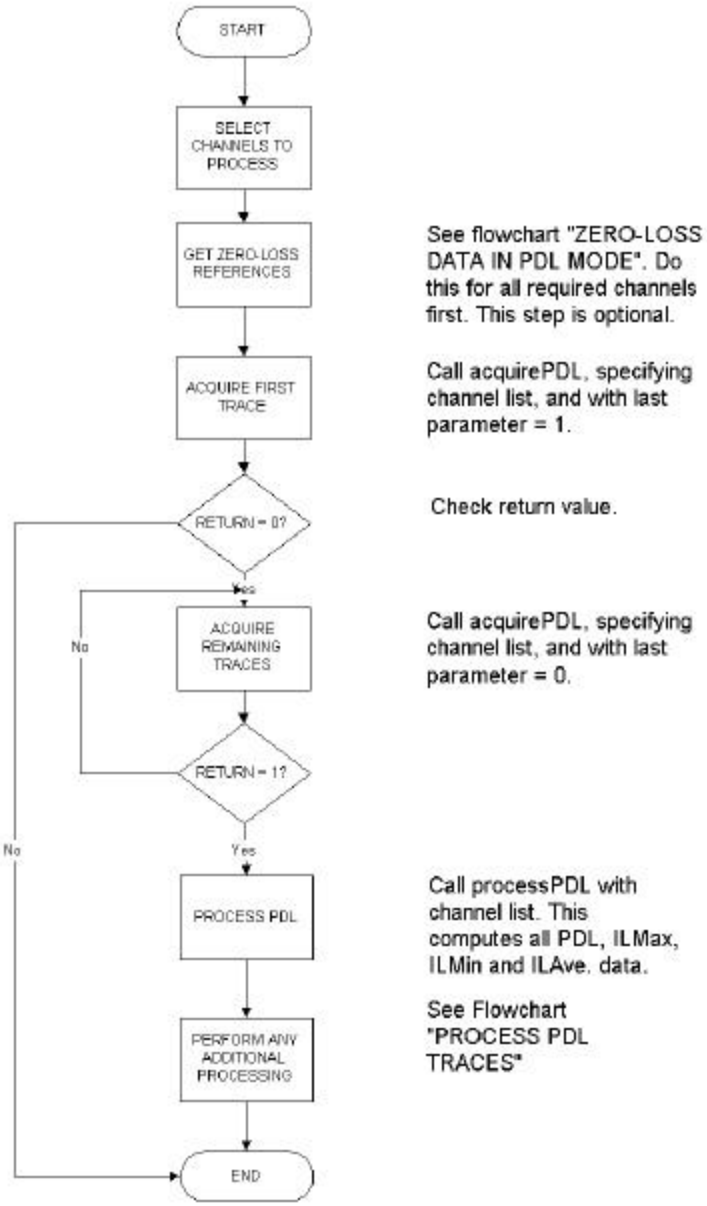
START
SELECT CHANNELS TO PROCESS
GET ZERO-LOSS REFERENCES
ACQUIRE FIRST TRACE
RETURN = 0?
Yes
No
ACQUIRE REMAINING TRACES
RETURN = 1?
No
Yes
PROCESS PDL
PERFORM ANY ADDITIONAL PROCESSING
END
See flowchart "ZERO-LOSS DATA IN PDL MODE". Do this for all required channels first. This step is optional.
Call acquirePDL, specifying channel list, and with last parameter = 1.
Check return value.
Call acquirePDL, specifying channel list, and with last parameter = 0.
Call processPDL with channel list. This computes all PDL, ILMax, ILMin and ILAve. data.
See Flowchart "PROCESS PDL TRACES"

Figure 102: PDL Mode Processing

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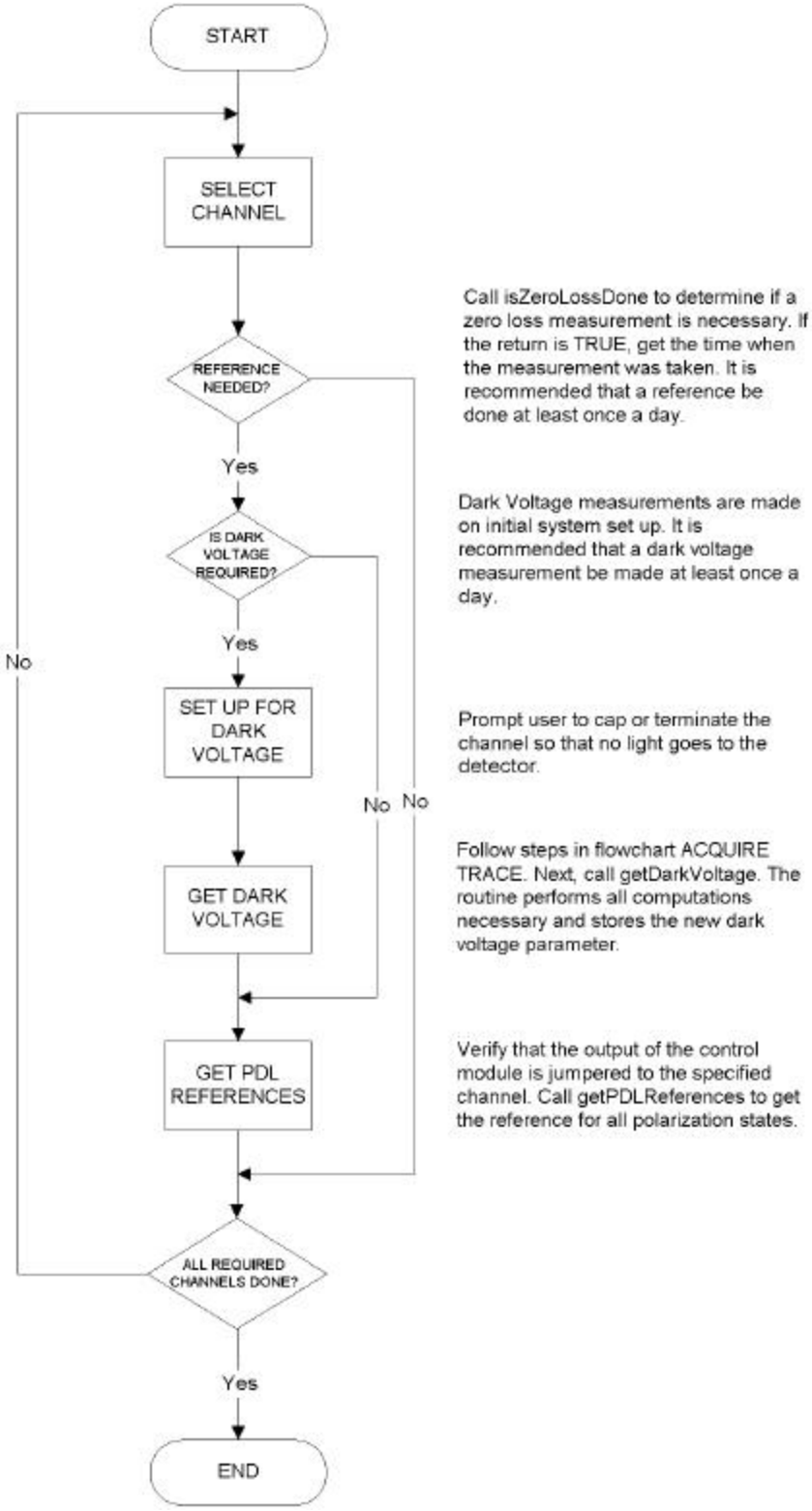
START
SELECT CHANNEL
REFERENCE NEEDED?
Yes
IS DARK VOLTAGE REQUIRED?
Yes
SET UP FOR DARK VOLTAGE
GET DARK VOLTAGE
GET PDL REFERENCES
ALL REQUIRED CHANNELS DONE?
Yes
END
No
No
No
Call isZeroLossDone to determine if a zero loss measurement is necessary. If the return is TRUE, get the time when the measurement was taken. It is recommended that a reference be done at least once a day.
Dark Voltage measurements are made on initial system set up. It is recommended that a dark voltage measurement be made at least once a day.
Prompt user to cap or terminate the channel so that no light goes to the detector.
Follow steps in flowchart ACQUIRE TRACE. Next, call getDarkVoltage. The routine performs all computations necessary and stores the new dark voltage parameter.
Verify that the output of the control module is jumpered to the specified channel. Call getPDLReferences to get the reference for all polarization states.

Figure 103: Zero Loss Data in PDL Mode

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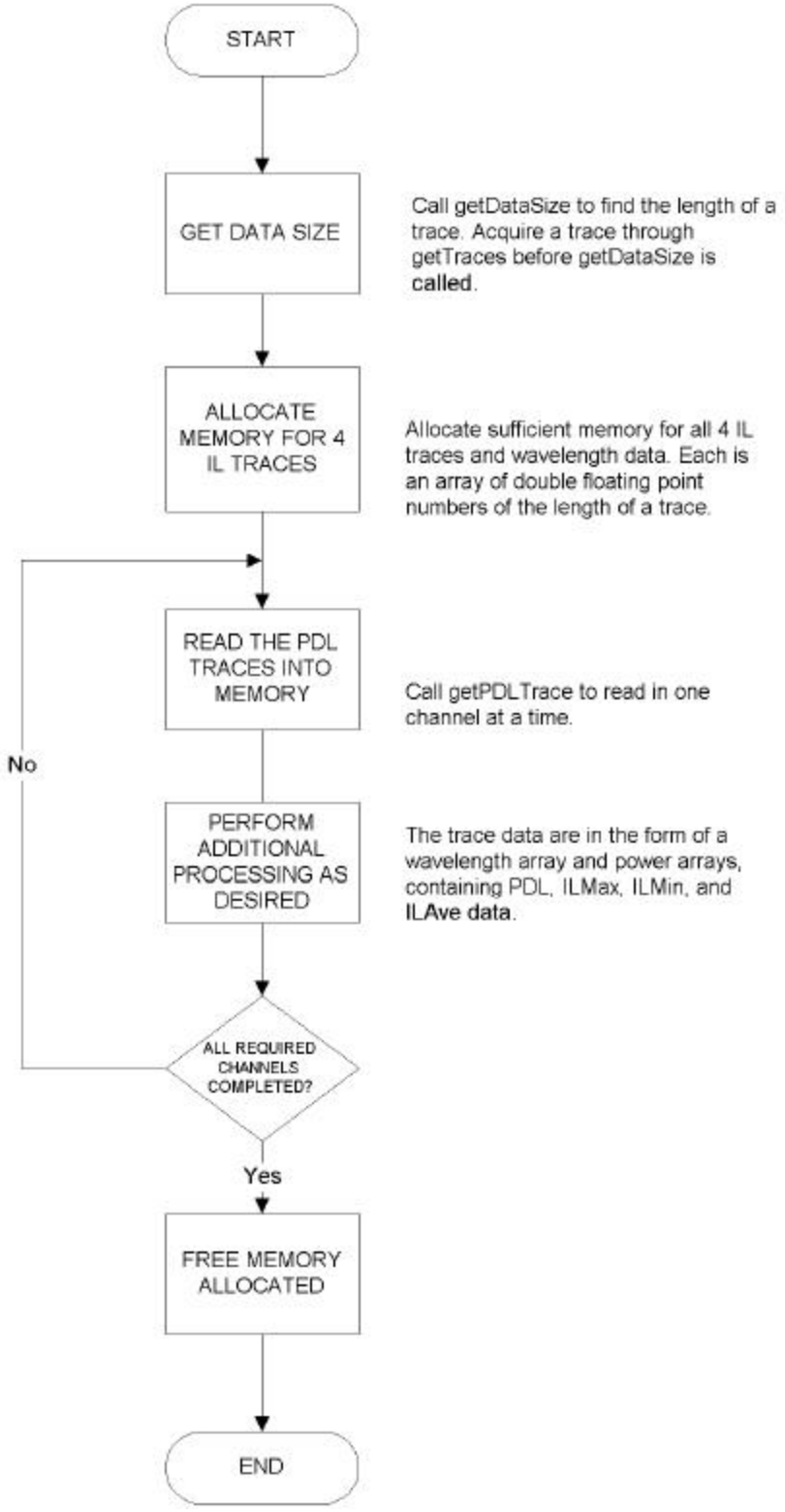
START
GET DATA SIZE
Call getDataSize to find the length of a trace. Acquire a trace through getTraces before getDataSize is called.
ALLOCATE MEMORY FOR 4 IL TRACES
Allocate sufficient memory for all 4 IL traces and wavelength data. Each is an array of double floating point numbers of the length of a trace.
READ THE PDL TRACES INTO MEMORY
Call getPDLTrace to read in one channel at a time.
No
PERFORM ADDITIONAL PROCESSING AS DESIRED
The trace data are in the form of a wavelength array and power arrays, containing PDL, ILMax, ILMin, and ILAve data.
ALL REQUIRED CHANNELS COMPLETED?
Yes
FREE MEMORY ALLOCATED
END

Figure 104: Additional PDL Processing

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External Control of the Source Optics Module

If the transmitter is in a remote or inaccessible location, or the user runs special applications that require different settings on the SOM, the user can opt to control the SOM remotely. The remote control requirements of the application program can be met using the RS232 Control port located on the back panel of the SOM. Alternatively, the SOM can be driven through a GPIB controller by connecting to the GPIB port on the back panel of the SOM.

To control the SOM using the RS232 or GPIB ports:

- The RS232 Control port can be connected to a computer using a standard RS232 extension cable with a DB9-M connector at one end (to the SOM RS232 Control port) and a DB-9F connector at the other (to the computer). If communication cannot be established with this cable, substitute it with a null-modem cable.

- If GPIB control is used, connect the GPIB port to the GPIB port of the controller. The default GPIB address of the SOM is 7, but the address can be changed using the REMOTE button on the SOM front panel.

Command Formats

The common commands used to control or query the SOM conform to ANSI/IEEE 488.2 standard syntax. Common commands applicable to the SOM are listed in the **Programming the Source Optics Module** section. All SOM-specific commands conform to the Standard Commands for Programmable Instruments (SCPI) command language, version 1995.0, also listed in the same section.

All commands to the SOM consist of a command header, a variable number of parameters, and a terminator.

Command headers are specific commands (keywords) recognizable by SOM. For example, SOURCE:WAVELENGTH:START is a keyword. Each command keyword (header) has a long and short form, either of which can be used in any command. The commands, described in Table 20 and Table 21 in the **Programming the Source Optics Module** section, show the short form of a command in uppercase. Headers are arranged in a tree with nodes. In the previous example, SOURCE is a node; below that node is another node, WAVELENGTH, that has the header START as one of the optional headers in that branch of the tree. Table 21 shows the header tree structure.

Commands must adhere to the following rules:

- Parameters are numerical values, expressions, channel lists, and other data that are entered after a header. They must be separated from each other by a comma (,) and from the header by a space ( ).

- Multiple commands can be entered in a single message, separated by semicolons (;).

- If the program header is a query, it must end with a question mark (?).

- The program header (command line) must be terminated using a terminator. The terminator can be <LF>, the linefeed character, or EOL in GPIB. The terminating sequence, <LF>, does

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not always appear in the sample program messages provided in this section, but it is implied.

- The query form of a command must end with a question mark (?).

- A command can be entered in either uppercase characters or lowercase characters.

Command Paths

To use a command in the command tree, the SOM must know the full path to the command. If the command is the first command in the program message, the command header must contain the full path to the command.

Subsequent commands in the same program message are automatically referenced in the same path as the previous command, unless the command header is preceded by a colon (:). When the header is preceded by a colon, the full path to the command must be included in the command header.

```
[:ROUTe]
    :CLOSe    <channel list>
        :STAT?
```

The following program messages are valid:

```
ROUTE:CLOSE (@1:4);CLOSE (@5:5)
ROUTE: CLOSE (@1:4);:ROUTE:CLOSE (@5:5)
ROUTE:CLOSE:STATE?
```

The following program messages are not valid:

```
ROUTE: CLOSE(@1:4);ROUTE:CLOSE (@5:5)    (no colon before second command)
ROUTE:CLOSE (@1:4);STATE?                (STATE? command at different level than CLOSE)
```

Optional Commands

Optional commands are commands that need not be explicitly included in the command path. If an optional command for a path exists, it is enclosed by square brackets ([ ]) in the command tree. If an optional command is implied in the first command of a program message, the command path for subsequent commands is determined as if the default command has been explicitly included in the first command header.

```
[:ROUTe]
    :CLOSe    <channel list>
        :STAT?
```

The following program messages are valid:

```
ROUTE:CLOSE (@3!4)
CLOSE (@3!4)
```


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The following program message is not valid:

CLOSE (@3!4):STATE? (the STATE? command is not at the same level as CLOSE)

Parameter Types

The acceptable parameter types for each command or query are listed in Table 20 and Table 21. Valid parameter types are:

- **Numeric Value**—Any value between 9.9E37 and -9.9E37. The value can be sent as an integer (154), a decimal (15.2), or an exponential number (4.5E6). The character data forms MIN (minimum), MAX (maximum), and DEF (default) are also valid.

- **NRf** —Any value between 9.9E37 and -9.9E37. The value can be sent as an integer (154), a decimal (15.2), or an exponential number (4.5E6). The character data forms MIN, MAX, and DEF are not valid.

- **Boolean**—0, 1, or ON, OFF, or TRUE, FALSE. Any other numeric value sent is rounded to the nearest integer. If the resulting integer is anything but 0, it is interpreted as 1.

- **Character**—A character string that contains no more than 12 characters. Each character in the string must be either an uppercase or a lowercase letter, a digit (0 to 9), or an underscore (_).

- **String**—Any character string. The characters in the string can be any ASCII character and the string can be of any length, unless otherwise specified in the command table. For the source optics module to recognize a single or double quotation mark (‘ or “) as part of the string (and not as the end of the string), two sequential single quotation marks or two sequential double quotation marks are used to represent a single quotation mark or a double quotation mark, respectively.

- **Non-decimal Numeric**—Any binary, octal, or hex value, where the non-decimal numeric values (xxxx) are preceded by the type (T). For example, in #Txxxx, T is defined as:
  - octal = # followed by q or Q
  - hex = # followed by h or H
  - binary = # followed by b or B

  The value (xxxx) following the type must be less than the decimal value 2^{32} and must conform to the following rules for each type:
  - octal values can only contain the numeric characters 0 to 7
  - hex values can only contain the numeric characters 0 to 9 and the letters A to F (both lowercase and uppercase are accepted)
  - binary values can only contain the numeric characters 1 and 0

  For example:
  - #Q12347 is a valid octal number
  - #ha57b2 is a valid hex number
  - #B010111 is a valid binary number

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Programming the Source Optics Module

The source optics module can be programmed using IEEE 488.2 and SCPI commands. Table 20 lists IEEE commands and Table 21 lists SCPI commands.

Table 20: IEEE 488.2 Common Commands

Command	Parameter	Response	Minimum	Maximum
*CLS	N/A	N/A	N/A	N/A
*ESE	NRf	N/A	0	255
*ESE?	N/A	NRf	0	255
*ESR?	N/A	NRf	0	255
*IDN?	N/A	String	N/A	N/A
*OPC	N/A	N/A	N/A	N/A
*OPC?	N/A	NRf	1	1
*OPT?	N/A	String	N/A	N/A
*RST	N/A	N/A	N/A	N/A
*SRE	NRf	N/A	0	255
*SRE?	N/A	NRf	0	255
*STB?	N/A	NRf	0	255
*TST?	N/A	NRf	0	1
*WAI	N/A	N/A	N/A	N/A

SCPI Command Tree

All commands, other than the IEEE 488.2 common commands, are listed in Table 21. The following abbreviations are used in the Command Status column on the computer screen:

- SC (SCPI-confirmed command)
- SA (SCPI-approved command)
- N (command is neither SCPI confirmed nor approved)

Table 21: SCPI SOM Commands

Command	Form	Parameters	Min	Max	Response
:STATus					
:OPERation					
:CONDition?					NRf
:ENABle	NRf				

(table continued)

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Command	Form	Parameters	Min	Max	Response
:ENABle?					NRf
:QUEStionable					
:CONDition?					NRf
:ENABle	NRf				
:ENABle?					NRf
:PRESet					
:SYSTem					
:ERRor?					NRf , String
:VERSion?					String
:INFOrmation?					
:TRIGGER					
:ABORT					
:SOURce					
WAVElength					
START	NRf				
START?					NRf
STOP	NRf				
STOP?					NRf
SWEEP					
DELAY	NRf				
DELAY?					NRf
TIME	NRf				
TIME?					NRf
MODE	NRf				
MODE?	NRf				
POWER					
LEVEL	NRf				
LEVEL?					NRf
:ROUT					
SCAN?					list
OPEN	list	Relay List	1	7	

(table continued)

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Command	Form	Parameters	Min	Max	Response
CLOSe	list	Relay List	1	7	
STATus?					list
:FCOUNT	NRf		15000	65534	
:FCOUNT?					NRf
:FMO	NRf				
:FMO?					NRf
:FLO	NRf				
:FLO?					NRf
:FSERIAL	Char				
:FDESC	Char				
:FDESC?					Char
:FACEty	NRf				
:FACEty?					NRf
:FINI	NRf				
:FINI?					NRf

SCPI Common Commands

The following tables describe the most common SCPI commands.

Clear Status Command

Syntax	*CLS
Function	Clears the following queues and registers: • Error queue • Standard event status register • Status byte register • Operation event register • Questionable event register If *CLS is sent immediately after a message terminating sequence, both the output queue and the MAV bit in the status byte register are cleared. *CLS also cancels the functions of *OPC and *OPC?.
Example	*CLS

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Standard Event Status Enable Register Command

Syntax	*ESE<space><numeric value> where 0 ≤ <numeric value> ≤ 255
Function	Sets the bits in the standard event status enable register. The numeric value is rounded to the nearest integer and converted to a binary number. The bits of the register are set to match the bit values of the binary number.
Example	*ESE 216 sets the standard event status enable register bits to 11011000.

Standard Event Status Enable Register Query

Syntax	*ESE?
Function	Returns the contents of the standard event status enable register as an integer that, when converted to a binary number, represents the bit values of the register
Example	*ESE? returns 216 if the standard event status enable register is set to 11011000.

Standard Event Status Register Query

Syntax	*ESR?
Function	Returns the contents of the standard event status register as an integer that, when converted to a binary number, represents the bit values of the register
Example	*ESR? returns 195 if the standard event status register is set to 11000011.

Identification Query

Syntax	*IDN?
Function	Returns a string that identifies the manufacturer, the source optics module model number, the serial number (or 0 if unavailable), and the firmware level
Example	*IDN? returns JDS Uniphase, SOM Version 1.1.0, EJ013784, 3.1.4

Operation Complete Command

Syntax	*OPC
Function	Causes the source optics module to set the OPC bit in the standard event status register when all pending operations have been completed
Example	*OPC

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Operation Complete Query

Syntax	*OPC?
Function	Places “1” in the output queue of the source optics module when all pending operations have been completed. The value 1 is not always placed in the output queue immediately; therefore, the status byte register must be polled and the MAV bit checked to determine if there is a message available in the output queue.
Example	*OPC?

Option Identification Query

Syntax	*OPT?
Function	Reports on options installed or included with the source optics module
Example	*OPT? returns ??? in all cases.

Reset Command

Syntax	*RST
Function	Restores the source optics module to the default setting
Example	*RST

Service Request Enable Command

Syntax	*SRE<space><numeric value> where 0 ≤ <numeric value> ≤ 255
Function	Sets the bits in the service request enable register. The numeric value is rounded to the nearest integer and converted to a binary number. The bits of the register are set to match the bit values of the binary number.
Example	*SRE 216 sets the service request enable register bits to 11011000.

Service Request Enable Query

Syntax	*SRE?
Function	Returns the contents of the service request enable register as an integer that, when converted to a binary number, represents the bit values of the register
Example	*SRE? returns 195 if the service request enable register is set to 11000011.

Read Status Byte Query

Syntax	*STB?
Function	Returns the contents of the status byte register as an integer that, when converted to a binary number, represents the bit values of the register. The bit value for bit 6 of the register is the MSS bit value, not the RQS bit value.
Example	*STB? returns 170 if the status byte register is set to 10101010.

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Self-Test Query

Syntax	*TST?
Function	Initiates a self-test of the source optics module and returns 0, when the source optics module passes the self-test, or 1, if it fails During self-testing, established optical paths are interrupted for approximately 10 seconds while the position of the switching mechanism is verified.
Example	*TST?

*WAI Command

Syntax	*WAI
Function	Prevents the source optics module from executing more commands or queries, until all previously pending operations are complete There are no consequences to this command because all commands are executed sequentially; therefore, any subsequent commands are completed by the time this command is parsed.
Example	*WAI

SCPI Status Commands

The following tables describe SCPI status commands.

:STATus:OPERation:CONDition?

Syntax	:STATus:OPERation:CONDition?
Function	Returns the contents of the operation condition register as an integer that, when converted to a binary number, represents the bit values of the register
Example	:STAT:OPER:COND?

:STATus:OPERation:ENABle

Syntax	STATus:OPERation:ENABle <space> <NRf>
Function	Sets the bits in the operation enable register. The NRf value is rounded to the nearest integer and converted to a binary number. The bits of the register are set to match the bit values of the binary number.
Example	:STATUS:OPERATION:ENABLE 33 sets bit 0 and bit 5 of the operation enable register to 1.

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:STATus:OPERation:ENABle?

Syntax	:STATus:OPERation:ENABle?
Function	Returns the contents of the operation event enable register as an integer that, when converted to a binary number, represents the bit values of the register
Example	:STAT:OPER:ENAB 23;ENAB? returns 23

:STATus:OPERation[:EVENT]?

Syntax	:STATus:OPERation[:EVENT]?
Function	Returns the contents of the operation event register as an integer that, when converted to a binary number, represents the bit values of the register
Example	:STAT:OPER:EVENT?

:STATus:QUEStionable:CONDition?

Syntax	:STATus:QUEStionable:CONDition?
Function	Returns the contents of the questionable condition register as an integer that, when converted to a binary number, represents the bit values of the register
Example	:STAT:QUES:COND?

:STATus:QUEStionable:ENABle

Syntax	:STATus:QUEStionable:ENABle <space> <NRf>
Function	Sets the bits in the questionable enable register. The NRf value is rounded to the nearest integer and converted to a binary number. The bits of the register are set to match the bit values of the binary number.
Example	:STATUS:QUESTIONABLE:ENABLE 33 sets bit 0 and bit 5 of the questionable enable register to 1.

:STATus:QUEStionable:ENABle?

Syntax	:STATus:QUEStionable:ENABle?
Function	Returns the contents of the questionable event enable register as an integer that, when converted to a binary number, represents the bit values of the register
Example	:STAT:QUES:ENAB 23;ENAB? returns 23

:STATus:QUEStionable[:EVENT]?

Syntax	:STATus:QUEStionable[:EVENT]?
Function	Returns the contents of the questionable event register as an integer that, when converted to a binary number, represents the bit values of the register

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Example	:STAT:QUES:EVENT?

:STATus:PRESet

Syntax	:STATus:PRESet
Function	Presets all the enable and transition registers in the questionable and operation structures to the following settings: • All bits in the ENABle registers are set to 0 • All bits in the positive transition registers are set to 1 • All bits in the negative transition registers are set to 0
Example	:STAT:PRES

:SYSTem:ERRor?

Syntax	:SYSTem:ERRor?
Function	Returns the error number and an error message from the error queue. See Table 19 for a list of error numbers and their associated messages.
Example	:SYST:ERR? returns: 0, “No error”

:SYSTem:VERSion?

Syntax	:SYSTem:VERSion?
Function	Returns the formatted numeric value the of the SCPI version number
Example	:SYST:VERS? returns: 1995.0

:SYSTem:INFOrmation?

Syntax	:SYSTem:INFOrmation?
Function	Returns the system information for the port specified
Example	:SYST:INFO? 1 returns: Module Type, Serial Number, Version Number, Description

User Commands

The following tables describe SCPI user commands.

[ROUTe]:SCAN?

Syntax	:[ROUTe]:SCAN?
Function	Returns the available channel list from the source optics module system
Example	:ROUT:SCAN?
Response	<channel_list>

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[ROUTe]:CLOSe

Syntax	:[ROUTe]:CLOSe <space><channel_list>
Function	Selects the channel list on which the GPIB processor is to operate on subsequent commands
Example	:ROUT:CLOS (@ 1:4)

:[ROUTe]:CLOSe:STATe?

Syntax	[ROUTe]:CLOSe:STATe?
Function	Returns the currently selected channels. For example, if channels 1 to 3, 4 to 5, and 5 to 7 are closed, the channel list is (@1:3,4:5,5:7).
Example	:CLOS (@1:2,3:5);:CLOS:STATE? returns (@1,2,3,4,5). (Do not forget the space between CLOS and the bracket.)
Response	<channel_list>

:SOURce:WAVElength:START

Syntax	:SOUR:WAVE:START <space><NRf>
Function	Causes the source optics module to change its internal start wavelength to the specified value. This value is used to command the laser on the next sweep.
Example	:SOUR:FREQ:START 1518.5

:SOURce: WAVElength:START?

Syntax	:SOUR: WAVE:START?
Function	Causes the source optics module to output its internal start wavelength used for laser control
Example	:SOUR:FREQ:START? returns 1518.5

:SOURce: WAVElength:STOP

Syntax	:SOUR: WAVE:STOP <space><NRf>
Function	Causes the source optics module to change its internal stop wavelength to the specified value. This value is used to command the laser on the next sweep.
Example	:SOUR:FREQ:STOP 1575.0

:SOURce: WAVElength:STOP?

Syntax	:SOUR: WAVE:STOP?
Function	Causes the source optics module to output its internal stop wavelength used for laser control

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Example	:SOUR:FREQ:STOP? returns 1575.0

:SOURce:SWEEP:DELAY

Syntax	:SOUR:SWEEP:DELAY <space><NRf>
Function	Causes the source optics module to changes its internal delay setting to the specified value. This value is used to set the delay in seconds between subsequent sweeps.
Example	:SOUR:SWEEP:DELAY 1.5

:SOURce:SWEEP:DELAY?

Syntax	:SOUR:SWEEP:DELAY?
Function	Causes the source optics module to output its internal variable used to control the laser's inter-sweep delay
Example	:SOUR:SWEEP:START? returns 1.5

:SOURce:SWEEP:TIME

Syntax	:SOUR:SWEEP:TIME <space><NRf>
Function	Causes the source optics module to changes its internal rate setting to the specified value. This value is used to set the rate, in seconds, for a laser sweep.
Example	:SOUR:SWEEP:DELAY 1.5

:SOURce:SWEEP:TIME?

Syntax	:SOUR:SWEEP:TIME?
Function	Causes the source optics module to output its internal variable used to control the laser's sweep rate
Example	:SOUR:SWEEP:TIME? returns 1.5

:SOURce:SWEEP:MODE

Syntax	:SOUR:SWEEP:MODE<space><NRf>
Function	Causes the source optics module to change its internal polarization mode setting to the specified value. This value is used to determine the polarization mode sequence.
Example	:SOUR:SWEEP:MODE 0

:SOURce:SWEEP:MODE?

Syntax	:SOUR:SWEEP:MODE?
Function	Causes the source optics module to output its internal variable used to control the laser's polarization mode

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Example	:SOUR:SWEEP:MODE?

:SOURce:POWER:LEVEL

Syntax	:SOUR:POWER:LEVEL <space><NRf>
Function	Causes the source optics module to changes its internal power setting to the specified value. This value is used to set the power output for the laser.
Example	:SOUR:POWER:LEVEL 3.0

:SOURce:POWER:LEVEL?

Syntax	:SOUR:POWER:LEVEL?
Function	Causes the source optics module to output its internal variable used to control the laser's output power level
Example	:SOUR:SWEEP:TIME? returns 3.0

:TRIGger

Syntax	:TRIG
Function	Causes the source optics module to go into a continuous mode of commanding the laser through a set of sweeps
Example	:TRIG

:TRIGer:?

Syntax	:TRIG?
Function	Returns the state of source optics module processing. Returns 1 if the source optics module is controlling the laser through continuos sweeps. Returns 0 if the OSM is idle and not controlling the laser.
Example	:TRIG? returns 1 if sweeping is in progress

:ABORt

Syntax	:ABOR
Function	Commands the source optics module to stop causing the laser to sweep repeatedly
Example	:ABOR

:FCOUNT

Syntax	:FCOUNT
Function	Sets the source optic module's internal variable for the required pulse count
Example	:FCOUNT

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:FCOUNT?

Syntax	:FCOUNT?
Function	Returns the source optic module's internal variable for the required pulse count
Example	:FCOUNT

:FMO

Syntax	:FMO
Function	Sets the source optic module's internal variable for FMO
Example	:FMO 516984.0

:FMO?

Syntax	:FMO?
Function	Returns the source optic module's internal variable for FMO
Example	:FMO?

:FLO

Syntax	:FLO
Function	Sets the source optic module's internal variable for FLO
Example	:FLO 542138766.0

:FLO?

Syntax	:FLO?
Function	Returns the source optic module's internal variable for FLO
Example	:FLO?

:FDESC

Syntax	:FDESC
Function	Sets the source optic module's internal description variable
Example	:FDESC

:FDESC?

Syntax	:FDESC?
Function	Returns the source optic module's internal description variable
Example	:FDESC?

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:FSERIAL

Syntax	:FSERIAL
Function	Sets the source optic module's serial number. The serial number is displayed with the *IDN? Command.
Example	:FSERIAL

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Reference

Troubleshooting

This section is to be used in the unlikely event that the Swept Wavelength System does not perform according to specification. It lists the symptoms of some faults, with procedures for troubleshooting each problem. The procedures described do not require the user to open any of the units or perform any task that requires extensive training.

Most of the tests require standard electrical and optical measurements. Equipment required to troubleshoot the SWS includes optical cleaning fluid and swabs, a fiber optics power meter, and a wavelength meter operating in the appropriate band.

The **Troubleshooting Flowcharts** section contains flowcharts to systematically identify the cause of any fault, and in most cases, to fix the problem. If the equipment failure cannot be corrected by the user, an SWS performance checklist, in the **Recording SWS Performance** section, is provided for the user to record system parameters and procedures performed when a problem has occurred. The checklist is used by the JDS Uniphase service hotline to help diagnose the problem, and it is to be returned with the equipment if factory repair is necessary.

If any problem cannot be solved by following the procedures listed in Table 22, contact the local JDS Uniphase representative or the service hotline. If it is necessary to return the laser to JDS Uniphase for repair, ship the unit only to the address given at the beginning of this document, following the procedure outlined in the **Getting Started** section.

Table 22: Troubleshooting

	Problem	Solution
1	When the Execute button is pressed on the SOM, an error message “laser timed-out” is displayed on the SOM.	Check the RS232 connection. Ensure that the cable is: • Marked PSTC 2463. • Connected to the Aux.1 of Laser port at the back of the SOM. • Connected to the RS232 port at the back of the tunable laser source. If the error persists, call the local JDS Uniphase representative or the service hotline.
2	Laser displays the error message “Limit Switch, Turn power off”.	Check the power setting on the SOM: • Ensure that the power setting is set at 3 dBm. If the power is set at a higher value, reset to 3 dBm. • Restart. If the problem persists, turn the laser power off. Contact the local JDS Uniphase representative or the service hotline to return the laser to the factory.

(table continued)

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Problem		Solution
3	On power-up, the laser displays “Initializing” for longer than 2 minutes.	Re-initialize the laser: • Switch off the laser using the key. • Wait at least 30 seconds. • Power on using the key. If the laser does not initialize, contact the local JDS Uniphase representative or call the service hotline.
4	When the Execute button is pressed on the SOM, an error message “increase span” is displayed on the SOM.	Check optical connections: • Verify that the green end of the PM fiber is connected to the Optical Output port of the tunable laser source. • Verify that the other end of the PM cable is connected to the Laser In port of the source optics module. • Clean the fiber connectors. • Reconnect and try again. If the problem persists, check the parameters of the source optics module: • Verify that the start wavelength is 1519.5 nm for C-band or 1540.8 nm for L-band. • Verify that the stop wavelength is 1575 nm for C-band or 1635 nm for L-band. • If the parameters are not as indicated, reset the parameters and try again. If the problem persists, check the power from the laser power: • Use a power meter to measure the power from the laser. • If the laser power is significantly (>3 dBm) lower than the value displayed on the laser display, the laser needs repair. Contact the local JDS Uniphase representative or the service hotline to arrange return of the laser to the factory.

(table continued)

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Problem		Solution
4	When the Execute button is pressed on the SOM, an error message “increase span” is displayed on the SOM.	If the laser power is within limits: • Press STOP on the SOM. • When SOM scanning has stopped, press REMOTE on the laser source front panel, if the LED is lit. • Set the laser wavelength to 1520.0 nm. • Press ENABLE on the laser source. • Use a wave meter to measure the wavelength. If the wavelength varies from 1520.0 nm by more than 200 pm, recalibrate the laser. • Set the laser wavelength to 1575.0 nm. • Measure the wavelength. If the wavelength varies from 1575.0 nm by more than 200 pm, recalibrate the laser. If the measured power continues to remain low, call the JDS Uniphase sales representative or the service hotline.
5	LEDs on the Control Module and the Detector Module show garbled digits during SWS software start up, not the CM01, C001, C002, etc., that is normally expected.	Check the pins on the connectors: • Turn the power off. • Remove the 50-pin ribbon cable at the back of the receiver chassis (OWB). • Repair or replace pins on the connector that are bent or broken. • Repair or replace pins on the connector on the computer interface card. • Reconnect the cable and start the program again. If the problem is not solved, the receiver needs repair. Call the local JDS Uniphase representative or the service hotline.
6	Computer display is blank on SWS start up.	Check receiver connections: • Cycle the power off and on to the receiver. • The SWS main window, or the main menu with a blank window, appears. If the problem persists, call the local JDS Uniphase representative or the service hotline.

(table continued)

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	Problem	Solution

7	When SWS application is running, an error message “system timed out” is displayed.	Check all system modules and connections:
		• Verify that the source optics module is scanning.
		• Verify that the tunable laser source is scanning.
		• Check the ribbon connection at the back of the receiver chassis. If it is plugged in properly:
		  • Unplug it.
		  • Verify that none of the connector pins are damaged.
		  • Reconnect the ribbon cable.
		  • Restart the SWS application.
		
		If the problem persists:
		• Verify that the SOM is scanning.
		• Verify that the tunable laser source is scanning.
		• With a power meter, measure the maximum power going into the receiver control module. The correct power is >-11 dBm.
		• Disconnect the fiber from the Signal Cond. Out port.
		• With a power meter, measure the maximum power going into the receiver control module. The correct power is >-11 dBm.
		• If the power is not >-11 dBm, connect the receiver to another SOM output port.
		• Measure the maximum power going into the receiver control module.
		
		If the problem persists, call the local JDS Uniphase representative or the service hotline.

(table continued)

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	Problem	Solution
8	Polarization state status bar, on the right bottom corner of the plot window, shows “unknown” or “unknown*****”. OR Error message “TPS Error” or “error 4006” is displayed.	This message can appear if the optional PDL controller is used or not. To ensure that the polarization state is detected properly: • Stop the software. • Press STOP on the SOM. • When the laser stops scanning, press DISPLAY. • In the display that appears on the SOM, record the value of the parameter Points. • If Points value is not displayed, the version of the firmware is not current. Call JDS Uniphase for assistance in determining the value of Points. • In the SWS15100.INI file in the C:\WINDOWS directory, ensure that the MaxPoints parameter is the same as the value of Points read from the SOM. If the file has been changed, close the software and re-open it before trying again. • If there is a data collection problem, as indicated by the continuation of the error message, inspect the ribbon connection to the I/O card on the back of the computer. If possible, replace the ribbon cable and run the program again. • Clean all optical connections, particularly the ones on the receiver control module, and try again. If the error persists, call the local JDS Uniphase representative or the service hotline to determine if repairs are needed.
9	Error message “Scan Request Error” appears when an attempt is made to acquire a trace.	Acquire a new scan: • Perform a zero loss reference for the channel and polarization state requested. • Acquire a trace. If the error persists, call the local JDS Uniphase representative or the service hotline.

(table continued)

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	Problem	Solution
10	A trace, displayed on the screen, shows very large insertion loss at all wavelengths.	Repeat insertion loss measurement: • Verify that the proper channel has been selected. • Disconnect the DUT that is connected to the channel. • Acquire a zero loss reference again. • Reconnect the DUT. • Repeat the measurement. • If insertion loss remains large, perform a reference and measure for insertion loss again. If the problem persists, call the local JDS Uniphase representative or the service hotline.
11	The characteristic wavelength of a known device seems to be measured incorrectly.	Check wavelength accuracy: • Check the wavelength calibration of the tunable laser source at 1520 nm and 1575 nm, using a standard wave meter. • If the calibration error is greater than 200 pm, recalibrate the laser source. • Verify wavelength accuracy using the built-in acetylene cell. • If known lines are off by more than 3 pm, recalibrate the system for wavelength (see the Error! Reference source not found. section). • Check the calibration by looking at several known peaks. • Save the old and new calibrations. • Run the SWS15100 program and measure a known device. • If the power levels are not correct, measure the power levels at critical points, such as input to the receiver control module and input to the device. The correct power levels are >-12 dBm and >-15 dBm. • Compute the loss through the control module; the correct loss is ≤3 dB. • If the control module is within specification, clean all connectors and try another device. If the problem persists, call the local JDS Uniphase representative. Repair of the control module is indicated.

(table continued)

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Problem		Solution
12	The noise seen on a trace, with only a fiber jumper, is greater than ±0.02 dB.	Verify the noise level: • Perform a zero loss reference. • Repeat the measurement in insertion loss mode. • Clean all connectors and repeat the measurement. • Change jumpers and try again. Verify power to the DUT: • Measure the power at the DUT with a power meter. The correct power level is >-15 dBm without a polarization controller and >-20 dBm with one. If the power is within this specification, but the noise persists, call the local JDS representative or the service hotline. Verify power to the control module: • If the power to the DUT is less than expected, measure the power going into the control module. Power is ~-11 dBm without a polarization controller or -14 dBm with a polarization controller. • If power to the DUT is within specifications, power is being lost in the control module. If power is lost in the control module, clean the UCAs on the control module: • Remove the UCA connectors on the CM. • Clean the connectors and exposed ferrules thoroughly, • Re-install the UCAs. • Perform a reference. • Acquire a trace. A persistent problem indicates that one of the UCAs is damaged. Verify the power at the UCA on the control module: • Measure the loss through each UCA. A small loss, such as ~0.02 dB, is acceptable. • If the loss is larger, replace the UCA and try again.

(table continued)

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Problem		Solution
12	The noise seen on a trace, with only a fiber jumper, is greater than ±0.02 dB.	Verify the power to the control module (CM) from the transmitter: • Verify that the UCAs are good. • Disconnect the polarization controller, if one is installed. • Attach a jumper between the Signal Cond. Out port and the Signal Cond. In port. • Verify that the laser is scanning. • Measure the power coming into the CM from the transmitter. The magnitude varies during this measurement. The true measurement is the value that stays steady for approximately one second as the laser is sweeping back to the start wavelength. • The maximum value of the power must be greater than: -5 dBm for a one-output transmitter -8 dBm for a two-output transmitter -11 dBm for a four-output transmitter • Measure the power at the output of the control module. • Compute the loss through the CM. If the loss through the CM is greater than 3 dB, call the local JDS Uniphase representative or the service hotline to return the CM for repair. If the power coming into the control module is low, check the fiber jumpers: • Check the fiber from the transmitter to the CM. The fiber must not be stressed in any way, or have kinks or sharp bends in it. • Clean the connectors at both ends of the fiber. • Clean the ferrule on the UCA on the source optics module. • Verify that the FC/PC connector is at the SOM end and that the FC/APC connector is at the control module end. • Perform a reference. • Acquire a trace.

(table continued)

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Problem		Solution
12	The noise seen on a trace, with only a fiber jumper, is greater than ±0.02 dB.	If noise persists, check the output from the SOM for low power: • Measure the power at the SOM output port. • If the power is less than -11 dBm, the power is low. Measure another port. • If the other port is within specification, take another reference. • Acquire another scan. If the problem is resolved, the source of the noise is either the UCA or the output port on the SOM. Replace the UCA and perform the measurements again. If the problem is caused by the output port of the SOM, contact the local JDS Uniphase representative or the service hotline to arrange replacement of the output cassette. The correct power at each of the output ports varies with the number of output ports. The correct power levels are: 1 output: -5 dBm 2 outputs: -8 dBm 4 outputs: -11 dBm If not enough power is output by the SOM: • Measure the power going into the SOM. The correct power level is ~3 dBm. • Measure the power coming out of the SOM at the Signal Cond. Out port. The correct power level is ~2 dBm. • If the power levels are not within specification, call the local JDS Uniphase representative or the service hotline to arrange repair of the SOM. • If the input power levels are within specification, but there is no output power, verify that the Signal Cond. In port and the Signal Cond. Out port are connected.

(table continued)

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Problem		Solution
12	The noise seen on a trace, with only a fiber jumper, is greater than ±0.02 dB.	If the power going into the SOM is too low, below 3 dBm, the laser is the source of the problem. If the laser is the problem: • Stop the scanning of the laser through the SOM. • Press the REMOTE button on the laser, if the REMOTE LED is on. • Calibrate the laser power. • Measure the output of the laser. If the laser power remains low, call the local JDS Uniphase representative or the service hotline.
13	In PDL mode, the PDL of the device is very noisy.	Verify PDL noise: • The PDL computation is sensitive to the power at which the measurement is made. Ignore PDL measurements for insertion losses greater than 40 dB. • If the PDL is noisy only at high insertion losses, there is no problem. • If the PDL is noisy at low insertion loss, try averaging over a few scans, or filtering, or both. If the problem persists, call the local JDS Uniphase representative or the service hotline.
14	While making PDL measurements, the PDL shows only noise at all wavelengths.	Verify that PDL measurements are being made: • Check the LEDs on the front panel of the polarization controller. The displayed PDL must cycle from 1 through 4. • If the cycle stays at one polarization, or if the display shows 0 at any time, check the RS232 connection to the polarization controller. • The correct cable has part number ED009172-A-00. One end plugs into the AUX2 port on the SOM, the other end connects to the RS232 Control on the back panel of the polarization controller. Verify the connections. • Verify the optical connections. The black PM fiber goes from the Signal Cond. Out port of the SOM to the IN port on the polarization controller. • The FC/PC-FC/PC jumper goes from the OUT port on the polarization controller to the Signal Cond. In port on the SOM.

(table continued)

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Problem		Solution
14	While making PDL measurements, the PDL shows only noise at all wavelengths.	If the problem persists: • Take another reference. • Acquire a new trace. If the problem persists, contact the local JDS Uniphase representative or the service hotline.
15	"Calibration Completed" is not returned after the "Re-Calibrate" button is pressed during performance of wavelength calibration.	Verify re-calibration: • Open the SWS15100.INI file in the C:\Windows or C:\WinNT directory. • Verify that the wavelengths of the two peaks are entered correctly. • Verify that the values of Threshold1 and Threshold2 are low enough to ensure that the peaks can be found. • If the values are not low enough, edit the SWS15100.INI file. • Restart the SWS software. • Perform the wavelength calibration again. If the problem persists, call the local JDS Uniphase representative or the service hotline.

Troubleshooting Flowcharts

The flowcharts in this section (Figure 105 to Figure 111) show the logical steps to use when troubleshooting the SWS. Ensure that the system is correctly assembled and the procedures described in the **Installation**, **Testing the SWS Components**, and **Testing the System** sections of this manual are followed. The **SWS Performance Checklist** is used to record the results of the testing, for reporting to the service hotline or the local JDS Uniphase representative.

The following flowcharts are listed in this section:

- Testing the system—see the flowcharts in Figure 105 and Figure 106
- Testing the SOM—see the flowchart in Figure 107
- Testing the receiver—see the flowcharts in Figure 108 and Figure 109
- Testing for system noise—see the flowchart in Figure 110
- Testing for SOM power—see the flowchart in Figure 111

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Testing the System

The flowcharts in Figure 105 and Figure 106 show the steps to follow when troubleshooting the whole SWS system.

Figure 105: Testing the System (first part)

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Figure 106: Testing the System (continued)

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Testing the Source Optics Module

The flowchart in Figure 107 shows the steps to follow when troubleshooting the source optics module.

Figure 107: Testing the SOM

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Testing the Receiver

The flowcharts in Figure 108 and Figure 109 show the steps to follow when troubleshooting the receiver.

Figure 108: Testing the Receiver (first part)

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Figure 109: Testing the Receiver (continued)

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Testing for System Noise

The flowchart in Figure 110 shows the steps to follow when troubleshooting for system noise.

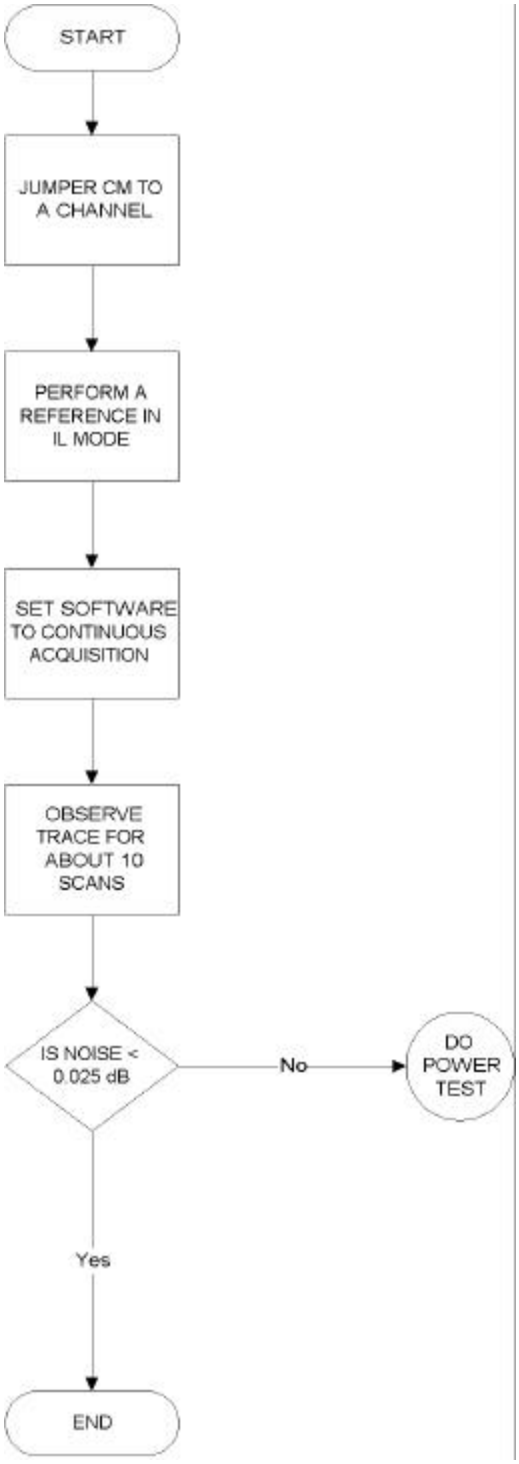

Figure 110: Testing for System Noise

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Testing Source Optics Module Power Levels

The flowchart in Figure 111 shows the steps to follow when troubleshooting for source optics module power.

Figure 111: Testing for SOM Power

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Parallel Port Interface Troubleshooting

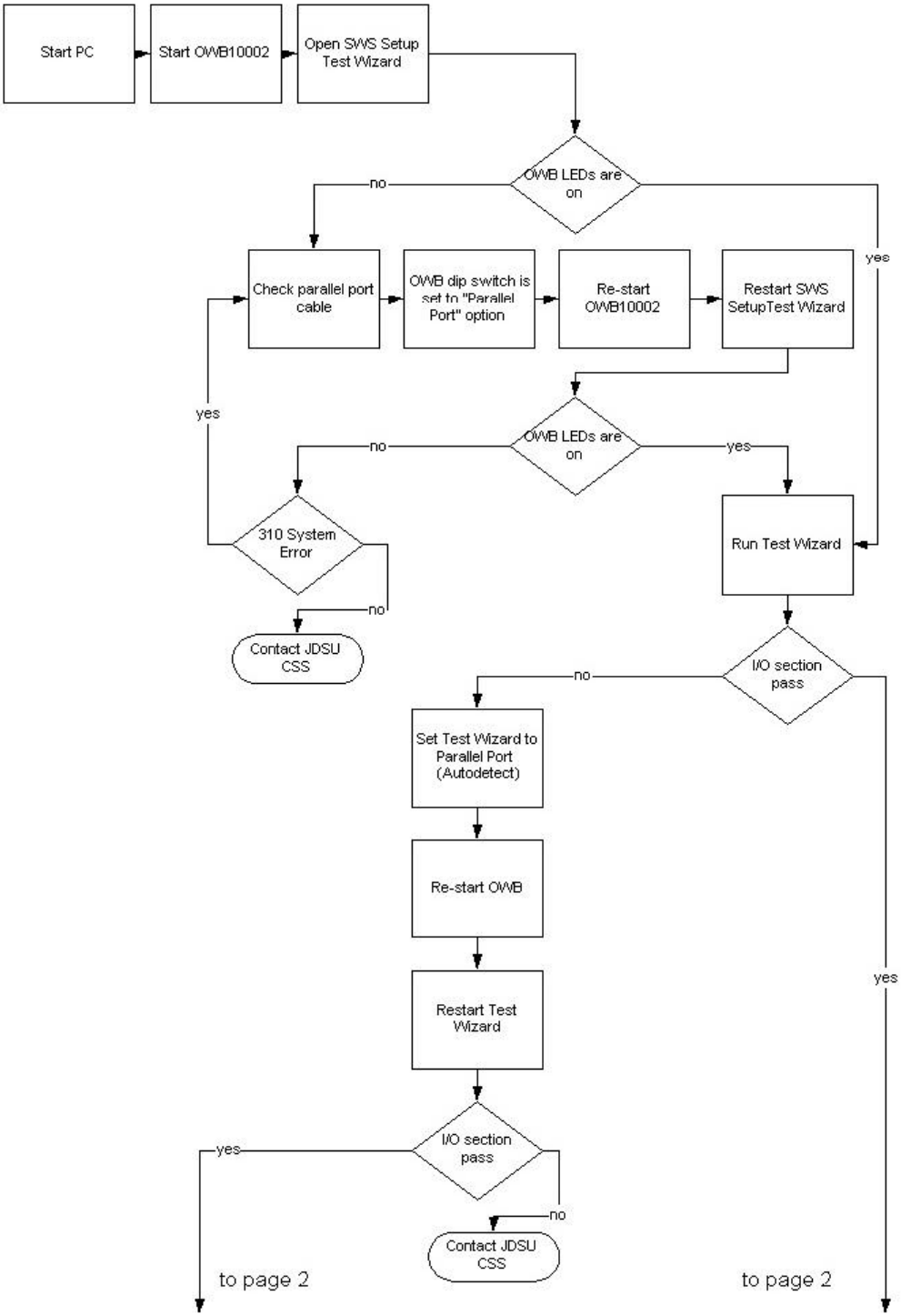

Figure 112. PPI Troubleshooting Procedure. Section 1.

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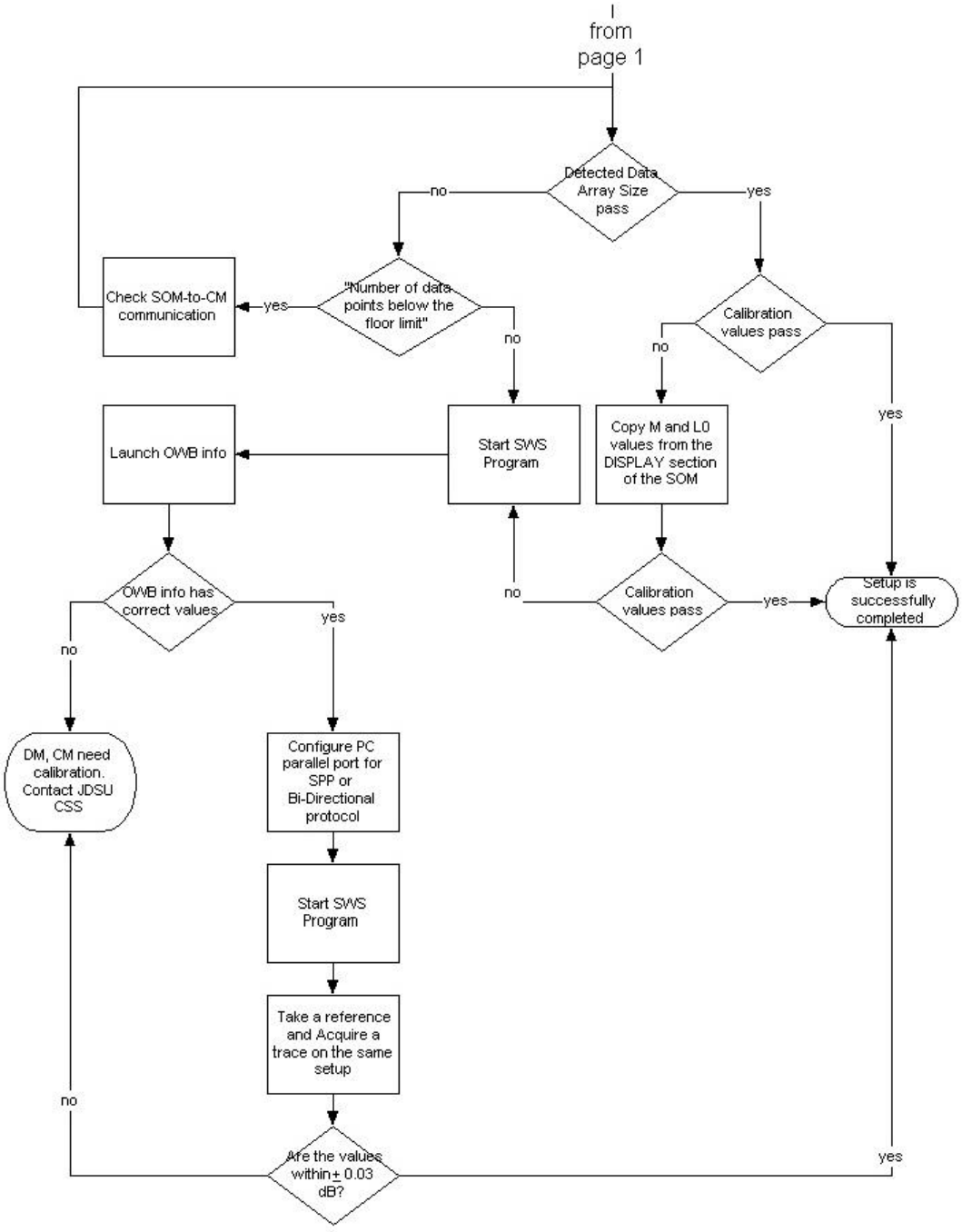

Figure 113. PPI Troubleshooting Procedure. Section 2.

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Recording SWS Performance

The SWS Performance Checklist is used as a diagnostic tool by the user and by technical support. After the tests in the **Troubleshooting** and **Troubleshooting Flowcharts** sections are performed, the checklist is filled out. The completed performance checklist is used when communicating with technical support.

The checklist lists measurements, conditions, and procedures performed by the user—information that is necessary for technical support to diagnose SWS problems. Add comments where more information than indicated is necessary for correct diagnosis. Attach your description of the faults or failures encountered.

There is a section for each component of the SWS. In each section, circle the appropriate options and enter the measured values. If a procedure has been performed that does not follow the standard procedures listed in this user's manual, list the steps as they were performed. Record any other abnormal conditions not listed on the checklist, for example, time of day of intermittent problems, power fluctuations caused by weather conditions, or other conditions that are unusual to the normal operating environment of the SWS.

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SWS Performance Checklist

Component	Condition	Measurement	Answer	Comment
Laser		What is the laser model number?	SWS15101 SWS16101	
	During power-up	Does the laser stay in “Initializing”?	YES NO	
	System running	Is the laser scanning properly?	YES NO	
	System stopped	What is the wavelength error at the start wavelength?		
	System stopped	What is the wavelength error at the stop wavelength?		
	System stopped	What is the power shown on the laser display?		
	System stopped	What is the laser power measured at the FC/PC end of the blue fiber?		
Polarization Controller		Is a polarization controller connected to the SOM?	YES NO	
		What is the polarization controller model number?	N/A SWS15104 SWS16104	
	System running	Are the digits on the display changing with each scan?	YES NO	
Source Optics Module		What is the SOM model number?	SWS15102 SWS16102	
	System running	What is the maximum power measured at the Signal Cond.Out port?		
	System running	Action: Reconnect Signal Cond.Out. What is the maximum power measured at output port 1?		
	System running	Action: Reconnect Signal Cond.Out.		

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Component	Condition	Measurement	Answer	Comment
		What is the maximum power measured at output port 2?		
Source Optics Module	System running	Action: Reconnect Signal Cond. Out. What is the maximum power measured at output port 3?		
	System running	Action: Reconnect Signal Cond. Out. What is the maximum power measured at output port 4?		
	System running	Action: Disconnect Signal Cond. Out. What is the maximum power measured at output port 1?		
Receiver		Action: Remove the connector at the TX IN port on the CM of the receiver. Measure power at this point. What is the power going to the CM?		
		How many receiver chassis are connected?		
		Is a compact two-channel receiver installed?	YES NO	
		How many channels does the receiver have?		
		Action: Reconnect the input to the CM. What is the power going to the DUT?		
		Action: Check the connection to the receiver. Is the receiver connected properly to the computer?	YES NO	
SWS Software	SWS software running	Are the LEDs on the receiver lit up?	YES NO	

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Component	Condition	Measurement	Answer	Comment
		What does the CM display read?		
		Do the LEDs read “C001”, “C002”, etc., up to the largest channel available?	YES NO	
SWS Software		Is the SWS program running correctly?	YES NO	
		Is an application running that was developed using the DLLs?	YES NO	
	SWS software running	What mode has been selected?	IL PDL	
		What polarization mode has been selected using software?	0 1 2 3 4	
		What is the polarization mode on the SOM?	0 1 2 3 4	
		What is the averaging setting? Mode: Weight: Number of samples:	PDL or IL	
		What is the smoothing half-filter size setting?		
		Are the traces displaying properly?	YES NO	
		Has Analysis been turned on?	YES NO	
		Have the markers been enabled?	YES NO	
		How many channels have been selected for traces?		
		How many channels have been selected for analysis?		
		Is the program running smoothly, with no long, unexplained delays?	YES NO	
		Has a known device been measured?	YES	

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Component	Condition	Measurement	Answer	Comment
			NO	
		Are there insertion loss errors?	YES NO	
		Are there wavelength errors?	YES NO	
SWS Software		Has a wavelength calibration been performed?	YES NO	
		Has the SWS software crashed during operation?	YES NO	
		Are DIAGNOSTICS enabled in the SWS15100.INI file?	YES NO	
		Is VALIDATE = 0 in the SWS15100.INI file?	YES NO	
Computer Interface		Is a data acquisition card installed and in use?	YES NO	
		Is a parallel port interface installed and in use?	YES NO	
		Are all receiver components, including all receiver chassis and the computer, and the monitor plugged into the same electrical circuit, on a single power bar?	YES NO	
		Is the electrical circuit properly grounded?	YES NO	
Device Measurement	SWS15100 program running	Action: Install device as DUT. Are references taken periodically, at least once a day, when characterizing devices?	YES NO	
		Has a dark voltage measurement been performed?	YES NO	
		When measuring an FBG in reflection, is the transmitted light properly	YES NO	

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Component	Condition	Measurement	Answer	Comment
		terminated?		
		What scan rate is being used to measure the device?		
		If set in continuous mode, does the IL vary from one scan to the next?		
Device Measurement		What mode is being used for measurement?	IL PDL	
		Are there any other devices, such as a circulator or a switch, between the CM and the device?	YES NO	
System Noise	SWS software running	Action: Take a zero-loss reference on one channel. Continuously acquire traces. The noise on the plot should be between -0.025 dB and +0.025 dB. What is the maximum magnitude of the noise seen on the plot?		
		Is the trace mostly less than this (~0.01 dB)?	YES NO	
		Is the trace flat around 0 dB?		
		Does the average value of the insertion loss drift, with time, by more than 0.005 dB?	YES NO	
		Does the noise start suddenly in the scan?	YES NO	
		Does the noise stop suddenly in the scan?	YES NO	
		Is the noise present on all scans?	YES NO	
		If the noise is intermittent, how frequently does it appear?		

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Component	Condition	Measurement	Answer	Comment
	System running	Action: Measure power to the device, with the system operating. What is the maximum power input to the DUT?		
NOTES				

Error Messages in SWS

Error Messages from the Tunable Laser Source

The error messages generated by the tunable laser source are listed in Table 23, with actions to take when the messages appear.

Table 23: Tunable Laser Source Error Messages

Error Message	Significance	Action
WARNING: User calib. err Press “Enter”	The user calibration is not correct.	The default value is used instead of the user calibration.
ERROR: no factory calib. Turn power off	There is no factory calibration.	Switch off the system and check the electrical connections. Power on. If the problem persists, call the service hotline.
DEFAULT Laser head disconnected	There is no connection between the head and the controller.	Switch off the system and check the electrical connections. Power on. If the problem persists, call the service hotline.
Value Error	The entered value is not in the valid range.	Press Enter. If the system is under remote control, check the interface connection and retry. If the error persists, the value is wrong. Enter a valid value.
Limit Switch Turn power off	There is a mechanical problem.	Switch the laser off and call the service hotline.
EEPROM error Turn power off	There is an electrical problem.	Switch the system off and call the service hotline.

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Error Messages from the Source Optics Module

The error messages generated by the SOM are listed in Table 24, with actions to take when the messages appear.

Table 24: SOM Error Messages

Error Message	Significance	Action
Increase Span	The required number of triggers are not being generated.	Verify that the laser is connected to the SOM input and that it is functional. If so, increase the stop wavelength by 1 nm. If the problem persists, call the service hotline.
VE	A value error is detected by the laser.	No operator action is required. The SOM recovers from this type of error.
CE	A command error is detected by the laser.	No operator action is required. The SOM recovers from this type of error.
Laser Timeout	The laser is not responding to commands.	Check the RS232 connection between the SOM (AUX1) and the laser. Verify that the correct cable is in use.

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Error Messages from the Software

The error messages generated by the application software are listed in Table 25, with actions to be taken when the messages appear.

Table 25: SWS Software Error Messages

Range	Description
0	No error
1-99	DOS error
100-199	SCPI Command error
200-299	SCPI Execution error
300-399	SCPI Device error
400-499	SCPI Query error
500	SCPI Power-on event
600	SCPI User Request event
700	SCPI Request Control event
800	SCPI Operation Complete event
801-1999	Reserved
2000-2999	GUI error
3000-3999	GPIB error
4000-4999	Data collector or SWS hardware error
5000-5999	Data processor error
6000-9999	Reserved
10001-19999	Sub error: This gives a more detailed description of the error.

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Detailed Error Messages

The error messages generated by the SWS software are listed in Table 26, with actions to take when the messages appear.

Table 26: SWS Software Error Messages

Error Number	Error Message	Possible Cause	Solution
2	No such file or directory	A file or directory required by the program was deleted.	Save the data and files created. Reinstall the software.
12	Not enough memory	The memory is corrupted.	Reboot the system.
28	No space left on device	The disk or device is full.	Delete unwanted files or try a new device (if it is a floppy diskette).
100	SCPI Command error		
300	Device-specific error		
310	System error		
311	Memory error		
360	Communication error		
2001	Failed to save Workspace file	The device is full.	Free up space.
4010	OWB hardware error	There is a hardware problem in the receiver.	Check all electrical and optical connections and try again. If the error persists, repair is indicated.
4020	No controller detected	The ribbon cable from the computer to the receiver is loose.	Check the ribbon connection and try again.
4030	No detector detected	The ribbon cable from the computer to the receiver is loose.	Check the ribbon connection and try again.
4040	OWB timeout	A timeout occurred during data collection.	Check all optical connections. If the problem persists, measure the power of the signal going to the input of the control module. Check that the SOM is operating.

(table continued)

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Error Number	Error Message	Possible Cause	Solution
4120	OWB data overflow	There are overlapping scans or a hardware error in the receiver detector module.	Increase the delay between scans, using the SOM front panel. If problem persists, return the detector module to JDS Uniphase for repair.
4210	Invalid Transmitter Polarization State (TPS)	The data collected does not correspond to the expected polarization.	Check that the source optics module is set to the same polarization state as the SWS application software. Verify that the software version number is 2.1.0 or greater. If it is not, call the local JDS Uniphase representative or the service hotline.
4220	Requested Polarization State is missing	A polarization state is not available.	Verify that the source optics module is set to provide the requested polarization state. Check that the polarization controller, if installed, is connected properly. If there is no PDL option, verify that the SWS software is in Insertion Loss mode (Mode menu).
5110	Diagnostics not available on your system. Call your local JDS Uniphase representative to have your SOM upgraded. Disable “Diagnostics” in the SWS15100.INI file.	Diagnostics are not available on the system.	Call the local JDS Uniphase representative to have the SOM upgraded. Disable “Diagnostics” in the SWS15100.INI file.
5120	Diagnostics have not been initialized. Perform wavelength calibration.	Diagnostics are not initialized.	Perform wavelength calibration.

(table continued)

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Error Number	Error Message	Possible Cause	Solution
5210	Laser is out of calibration. Recalibrate the laser and then perform wavelength calibration.	The laser is out of calibration.	See the user's manual for the tunable laser source to recalibrate the laser. Then perform a wavelength calibration (see the Error! Reference source not found. section).
5220	Error in wavelength measurement. If the error persists, call your local JDS Uniphase representative.	There is an error in wavelength measurement.	Cycle the power on and off on the tunable laser source by turning off the unit using its key, waiting at least 30 seconds after the power is off, and turning the unit back on using the key.
5310	The Zero Loss of a certain Polarization State of a specified channel is missing	The reference for the channel has not been taken.	Perform a zero loss (reference) measurement.
5330	Dark Voltage Measurement error. Too much light in the specified detector.	The detector is not capped.	Cap the detector to ensure that all light to the detector is blocked. Try again. If error persists, call the local JDS Uniphase representative, or the service hotline.

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How the SWS Calculates Values

A value of n indicates an integer; a value of x indicates a real number.

Threshold Power

Threshold power is set by the user. All calculations are performed at x dB, or the equivalent fraction, below the baseline or the peak, or x dB, or the equivalent fraction, above the baseline or the peak, as specified by the user. The baseline is computed by repeatedly averaging the signal.

Wavelength at the Minimum

The wavelength at the minimum in the signal is found by searching for the absolute minimum signal, if the signal has a minimum. The user specifies whether the signal has a minimum or a maximum.

Minimum Power

The minimum power value is the value of the absolute minimum signal levels, regardless of the noise.

Wavelength at the Maximum

The wavelength at the maximum in the signal is found by searching for the absolute maximum signal, if the signal has a maximum. The user specifies whether the signal has a minimum or a maximum.

Maximum Power

The maximum power value is the value of the absolute maximum signal levels, regardless of the noise.

Center Wavelength using a Threshold Relative to the Baseline

The SWS calculates center wavelength using the following procedure:

1. Find the specified peak (minimum or maximum) signal level. Store the wavelength at which the level occurs.

2. Find the average baseline of the signal. Other levels are defined relative to average baseline.

3. At a power level x dB from the average baseline (Step 2), find the shorter wavelength (λ_L) nearest to the signal. The wavelength is determined by finding two data points, one to the left of the wavelength at which the signal crosses x dB, and one to the right of that wavelength. The wavelength (λ_L) corresponding to x dB is interpolated from these two data points. The search is begun, starting outward (left) from the peak position.

4. At the same level (x dB from the baseline), find the longer wavelength (λ_R) nearest to the signal, as in Step 3. The search is begun, moving outward (right) from the peak position.

5. Compute the center wavelength (CW) as the mean of the two, $(\lambda_R + \lambda_L)/2$.

6. Find the two data points of the signal nearest the CW.

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7. Get the power at each of these points.

8. Interpolate to find the power at the center wavelength from these points.

Center Wavelength using a Threshold Relative to the Peak

The SWS calculates center wavelength using the following procedure:

1. Find the specified peak signal level. Store the wavelength at which the level occurs.

2. At a power level x dB from the peak found in Step 1, find the shorter wavelength (λ_L) nearest to the signal. The wavelength is determined by finding two data points, one to the left of the wavelength at which the signal crosses x dB, and one to the right of that wavelength. The wavelength (λ_L) corresponding to x dB is interpolated from these two data points. The search is begun, starting outward (left) from the peak position.

3. At the same level (x dB from the peak), find the longer wavelength (λ_R) nearest to the signal, as in Step 2. The search is begun, moving outward (right) from the peak position.

4. Compute the center wavelength (CW) as the mean of the two, $(\lambda_R + \lambda_L)/2$.

5. Find the two data points of the signal nearest the CW.

6. Get the power at each of these points.

7. Interpolate to find the power at the center wavelength from these points.

Power at the Center Wavelength

The power at the data sample nearest the center wavelength is reported as the power at the center wavelength.

Bandwidth

Finding Bandwidth using a Threshold Relative to the Baseline

The algorithm used by the SWS to find the bandwidth is:

1. Find the specified peak signal level. Store the wavelength at which this occurs.

2. Find the average baseline of the signal, relative to which other levels are defined.

3. At a power level x dB from the baseline found in Step 2, find the shorter wavelength (λ_L) nearest to the signal. The wavelength is determined by finding two data points, one to the left of the wavelength at which the signal crosses x dB, and one to the right of that wavelength. The wavelength (λ_L) corresponding to x dB is interpolated from these two data points. The search is begun, starting outward (left) from the peak position.
4. At the same level (x dB from the baseline), find the longer wavelength (λ_R) nearest to the signal, as in Step 3. The search is begun, moving outward (right) from the peak position.

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5. Compute the bandwidth of the device, as the difference between the two wavelengths (λ_R - λ_L).

Finding Bandwidth using a Threshold Relative to the Peak

The algorithm used by the SWS to find the bandwidth is:

1. Find the specified peak signal level (the peak). Store the wavelength at which this occurs.

2. At a power level x dB from the peak found in Step 1, find the shorter wavelength (λ_L) nearest to the signal. The wavelength is determined by finding two data points, one to the left of the wavelength at which the signal crosses x dB, and one to the right of that wavelength. The wavelength (λ_L) corresponding to x dB is interpolated from these two data points. The search is begun, starting outward (left) from the peak position.

3. At the same level (x dB from the peak), find the longer wavelength (λ_R) nearest to the signal, as in Step 2. The search is begun, moving outward (right) from the peak position.

4. Compute the bandwidth of the device, as the difference between the two wavelengths (λ_R - λ_L).

Averages

Two types of averaging are implemented. The first type is averaging over a number of traces, which is done in single scan mode. In this form of averaging, n successive scans are added together and the sum is divided by n. The addition and averaging are performed on the insertion loss in linear scale, not in dB. At the end of each scan, the current average is converted to dB and displayed.

The second method is weighted averaging used in continuous scan mode. Weighted averaging is performed using the following algorithm, where w (0.0 < w < 1.0) is the chosen weight:

$$\text{Average[pass\_1]} = \text{Reading[pass1]}$$
$$\text{Average[pass\_2]} = (w \times \text{Average[pass\_1]} + (1\text{-}w) \times \text{Reading[pass\_2]})$$
$$\text{Average[pass\_3]} = (w \times \text{Average[pass\_2]} + (1\text{-}w) \times \text{Reading[pass\_3]})$$
$$\text{Average[pass\_4]} = (w \times \text{Average[pass\_3]} + (1\text{-}w) \times \text{Reading[pass\_4]})$$

Or, generally:

$$\text{Average[pass\_n]} = [w \times \text{Average[pass\_(n-1)]} + (1\text{-}w) \times \text{Reading[pass\_n]}]$$

In this example, “Reading” are measured insertion losses in linear power scale. At the end of each scan, the running average is converted to dB and displayed.

Minimum Loss in PDL Mode

In PDL mode, the minimum insertion loss is computed at each wavelength, without respect to the polarization. To compute this, the Mueller matrix is computed from the insertion loss measurement at the four linearly independent polarization states produced by the four-state polarization controller. From the Mueller matrix, the polarization vector that produces the

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minimum insertion loss is computed. The Mueller matrix is then used to find the insertion loss for this polarization state.

The minimum insertion loss shown is the minimum that is possible for the device at the stated wavelength, without respect to the polarization state.

Maximum Loss in PDL Mode

In PDL mode, the maximum insertion loss is computed at each wavelength, without respect to the polarization. To compute this, the Mueller matrix is computed from the insertion loss measurement at the four linearly independent polarization states produced by the four-state polarization controller. From the Mueller matrix, the polarization vector that produces the maximum insertion loss is computed. The Mueller matrix is then used to find the insertion loss for this polarization state.

The maximum insertion loss shown is the maximum that is possible for the device at the stated wavelength, without respect to the polarization state.

Any insertion loss measurement made on the device must fall within the minimum and maximum envelopes, as defined.

Polarization Dependent Loss

The PDL of a device is the positive difference between the maximum and minimum insertion losses, in linear power scale. The loss is converted to dB and displayed as a function of wavelength.

Passband

The passband of a device is the bandwidth calculated at a specified threshold, relative to the center wavelength of the device, the ITU center wavelength, or the center wavelength of a predefined custom channel. This wavelength is referred to as the reference wavelength. The power at the specified threshold is found relative to the reference wavelength and the bandwidth is computed at this power level.

Flatness

The flatness of the device is a measure of the slope of a straight line that is a best linear fit to the top of the trace in a given channel. Flatness is calculated by finding the difference in power between the two points where the line crosses the band edges. The user defines whether to use passband, bandwidth, or some other numerical range.

Crosstalk

Crosstalk (Left Crosstalk or Right Crosstalk) is the difference between the minimum power within the reference passband and the maximum power in the adjacent (left or right) channel.

Cumulative Crosstalk (TXT)

Cumulative, or total, crosstalk is the difference between the minimum power within a passband around the reference channel, and the sum of the peak powers at all the other channels.

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Measuring Parameters

The following figures show how to measure and calculate bandwidth, passband, flatness, and crosstalk.

Figure 114 shows how to measure bandwidth.

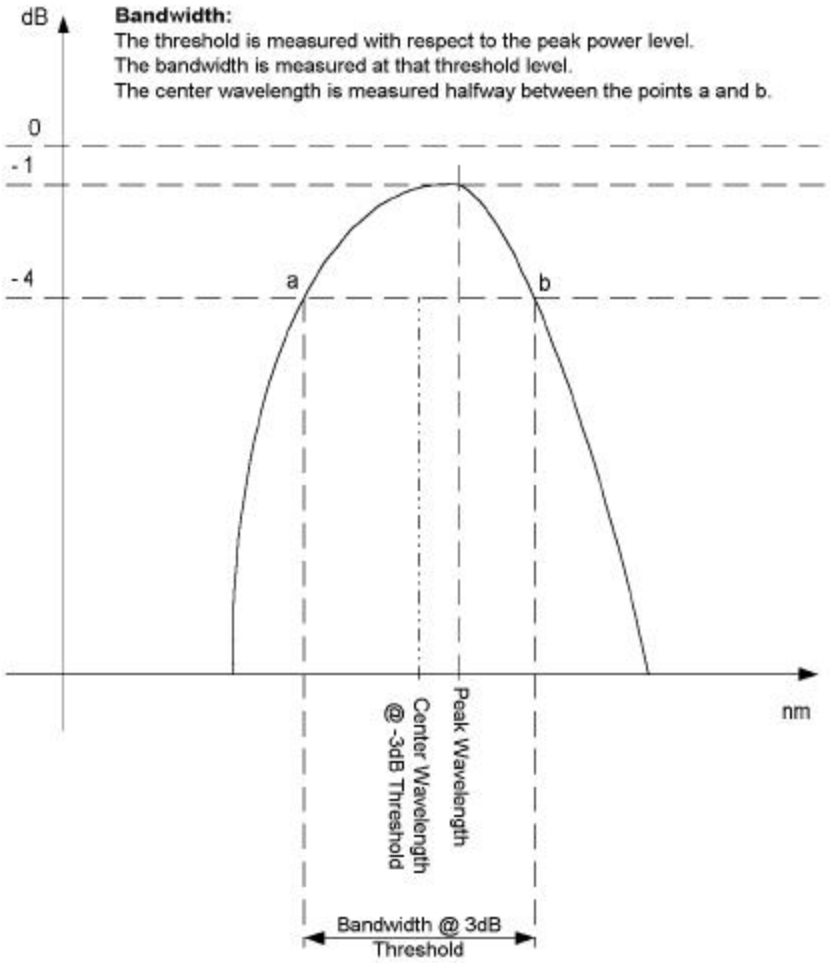

Figure 114: Calculating Bandwidth

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Figure 115 shows how to measure passband.

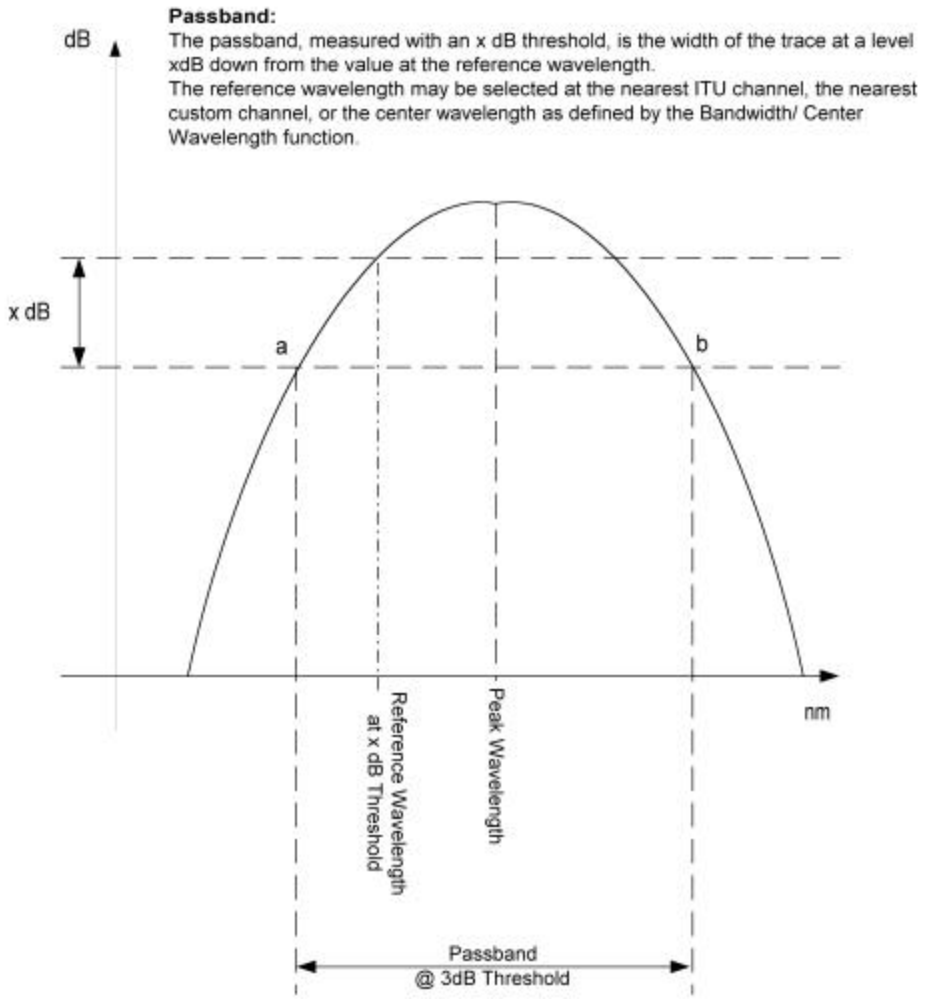
Passband:
The passband, measured with an x dB threshold, is the width of the trace at a level xdB down from the value at the reference wavelength.
The reference wavelength may be selected at the nearest ITU channel, the nearest custom channel, or the center wavelength as defined by the Bandwidth/ Center Wavelength function.
dB
x dB
a
b
nm
Reference Wavelength at x dB Threshold
Peak Wavelength
Passband @ 3dB Threshold

Figure 115: Calculating Passband

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Figure 116 shows how to measure flatness.

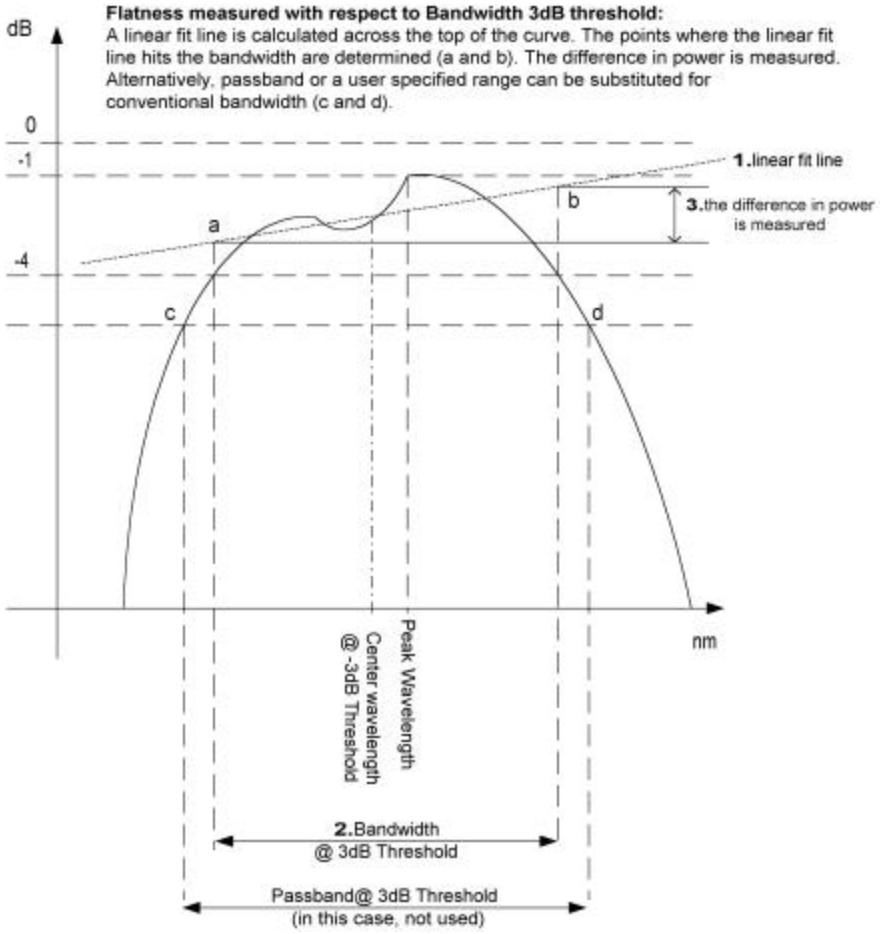
Flatness measured with respect to Bandwidth 3dB threshold:
A linear fit line is calculated across the top of the curve. The points where the linear fit line hits the bandwidth are determined (a and b). The difference in power is measured. Alternatively, passband or a user specified range can be substituted for conventional bandwidth (c and d).
dB
0
-1
-4
1.linear fit line
3.the difference in power is measured
a
b
c
d
nm
Center wavelength @ -3dB Threshold
Peak Wavelength
2.Bandwidth @ 3dB Threshold
Passband@ 3dB Threshold (in this case, not used)

Figure 116: Calculating Flatness

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Figure 117 shows how to measure right crosstalk. Left crosstalk is measured in a similar manner.

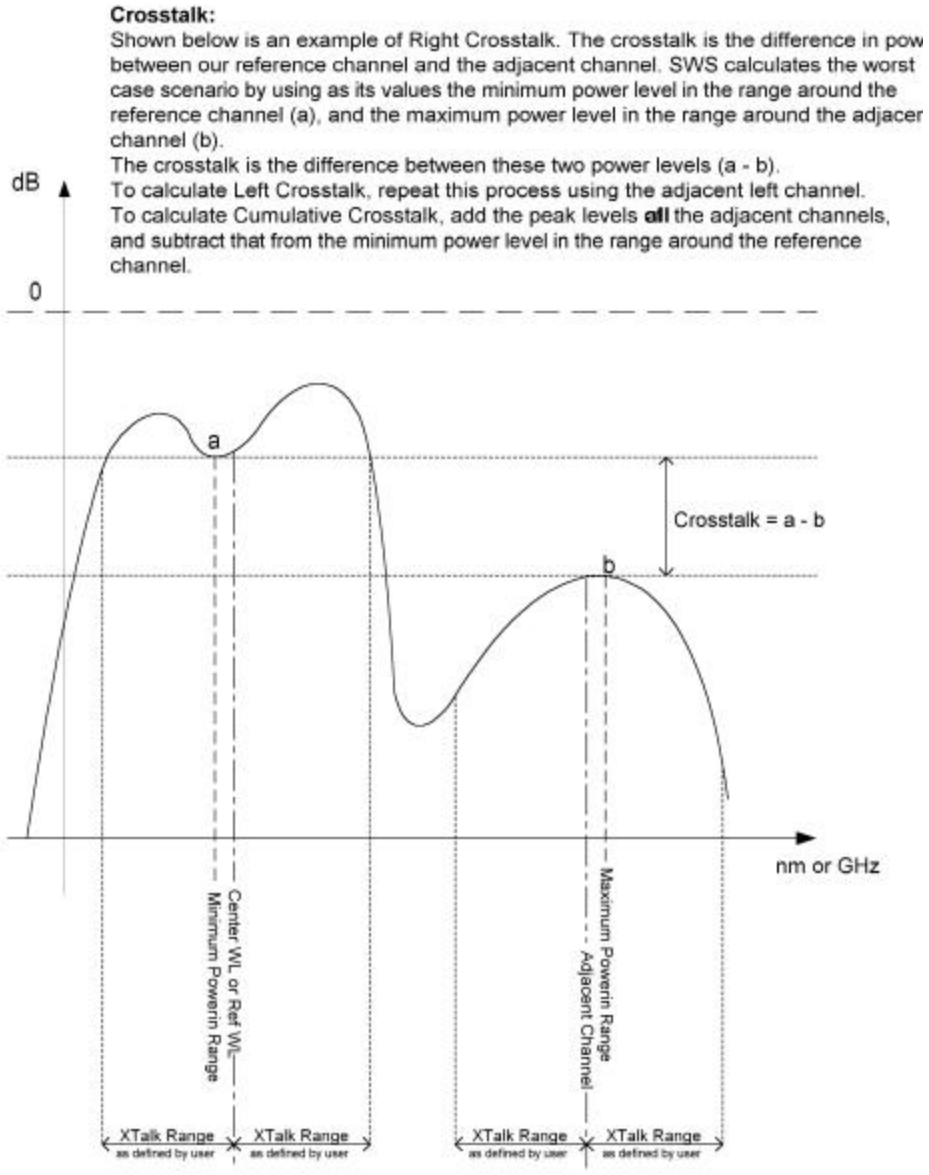
Crosstalk:
Shown below is an example of Right Crosstalk. The crosstalk is the difference in pow
between our reference channel and the adjacent channel. SWS calculates the worst
case scenario by using as its values the minimum power level in the range around the
reference channel (a), and the maximum power level in the range around the adjacer
channel (b).
The crosstalk is the difference between these two power levels (a - b).
To calculate Left Crosstalk, repeat this process using the adjacent left channel.
To calculate Cumulative Crosstalk, add the peak levels all the adjacent channels,
and subtract that from the minimum power level in the range around the reference
channel.
dB
0
a
b
Crosstalk = a - b
nm or GHz
Center WL or Ref WL
Minimum Powerin Range
Maximum Powerin Range
Adjacent Channel
XTalk Range
as defined by user
XTalk Range
as defined by user
XTalk Range
as defined by user
XTalk Range
as defined by user

Figure 117: Calculating Right Crosstalk

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